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The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water

ENGINEERING FEASIBILITY DESIGN REPORT

SUPPORTING DOCUMENT 2:

DAM POSITION REPORT

FINAL

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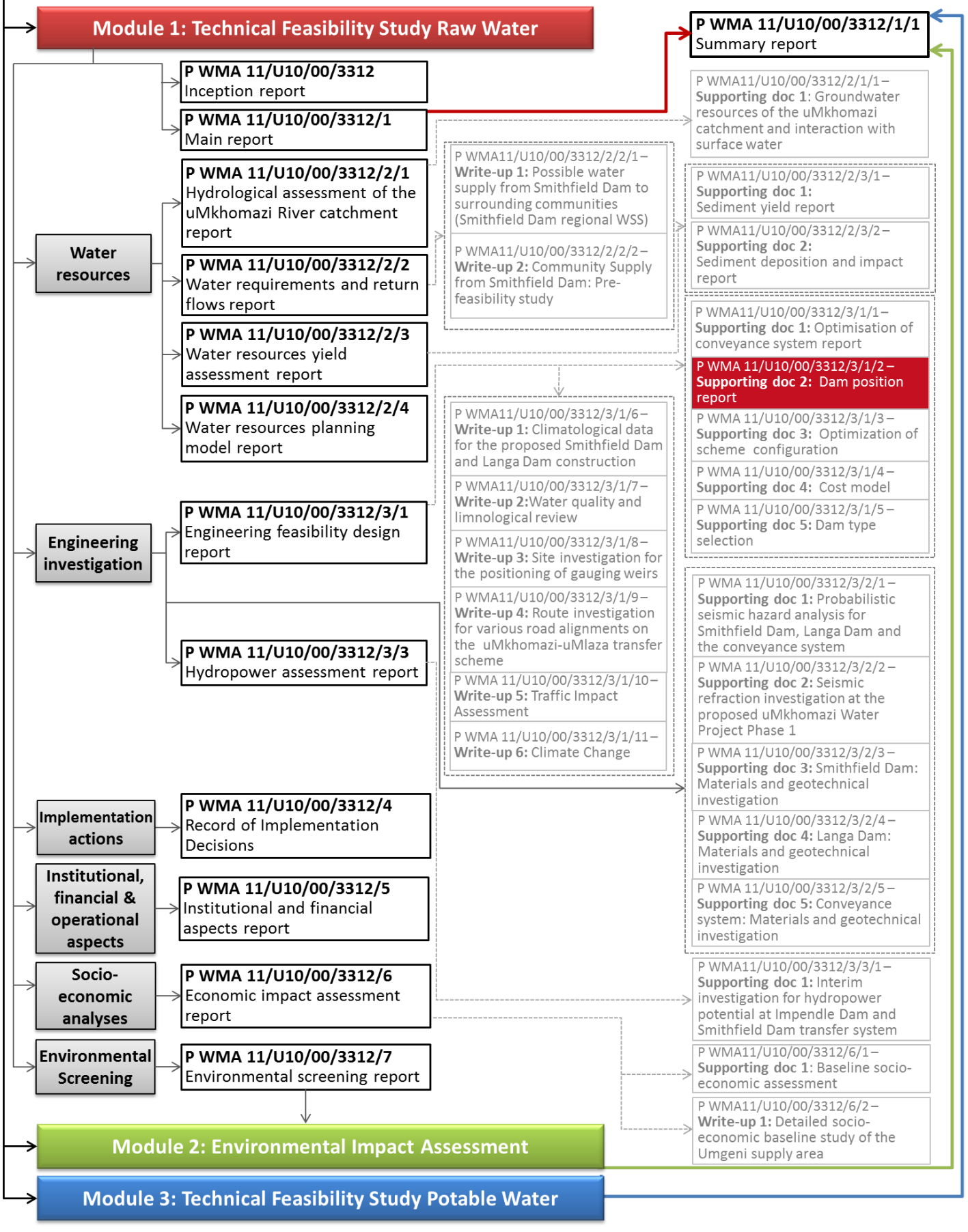
PREAMBLE

In June 2014, two years after the commencement of the uMkhomazi Water Project Phase 1 Feasibility Study, a new Department of Water and Sanitation was formed by Cabinet, including the formerly known Department of Water Affairs.

In order to maintain consistent reporting, all reports emanating from Module 1 of the study will be published under the Department of Water Affairs name.

The uMkhomazi Water Project Phase 1

LIST OF REPORTS



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LIST OF ABBREVIATIONS

BOR	Bottom of River
TOR	Terms of Reference
MAR	Mean annual runoff
MOL	Minimum operating level
FSL	Full supply level
DWA	Department of Water Affairs
ECRD	Earth Care Rockfill Dam
EED	Earthfill Embankment Dam
RCCG	Roller Compacted Concrete Gravity Dam

LIST OF UNITS

Mm^3	Million cubic metres
Mm^3/a	Million cubic metres per annum
m^3/s	Cubic metres per second
Mℓ/d	Mega litres per day
masl	Metres above sea level
Tc	Time of Concentration

1 INTRODUCTION

This report forms part of the feasibility study on the Water Project Phase 1: Module 1: Technical Feasibility Study Raw Water. More specifically it covers the *Dam Position Task 5.2* as part of the *Engineering Investigations Task 5*. The Engineering Investigation main task consists of the following tasks shown in **Table 1.1**.

Table 1.1: Tasks of the Engineering Investigation Task

Task number	Task description
5.1	Optimization of Conveyance System
5.2	Dam Position
5.3	Materials Investigation
5.4	Geomorphologic and Seismic Investigation
5.5	Geotechnical Investigation
5.6	Survey
5.7	Dam Type Selection
5.8	Establish required Capacity of Dam
5.9	Flood and Backwater calculations for the Final Dam
5.10	Climatological Data for the Construction Site
5.11	Water Quality and Limnological Review
5.12	Sediment Yield
5.13	Land requirements and associated costs
5.14	Optimize Scheme Configuration
5.15	Assessment of the Potential for Hydropower
5.16	Feasibility Design of the Selected Scheme
5.17	Creating a Cost Model for the Project

The purpose of this report is, in conjunction with *Task 5.1: Optimization of the conveyance system*, to:

- Consider alternative dam sites for the Smithfield Dam;
- Finally determine the Smithfield Dam site matching the recommended conveyance layout; and to
- Identify the position of the balancing dam site downstream of the conveyance structure.

The pre-feasibility study concluded that the dam located at Site B, see **Figure 2.1**, in the uMkhomazi River and pumping from the Smithfield Dam reservoir at position of Site A, **Figure 2.1**, to the intake of a free-flow tunnel was the preferred transfer option.

This option was included in the comparison of options as described in the report of *Task 5.1*.

A layout of the proposed conveyance scheme is included in this report, see **Figure 2.4**.

This report will be attached in an Appendix to the Feasibility Study Report.

2 DAM SITE OPTIONS

2.1 SMITHFIELD DAM

The identified possible Smithfield Dam sites are indicated on **Figure 2.1** and are from upstream to downstream in the river the following:

- Site A, a site selected, during this feasibility study, upstream of the entrance to the conveyance structure which was selected during the pre-feasibility study. This position will enable releases to the conveyance structure from the outlet structure of the dam;
- Site B, the pre-feasibility study site, which has a saddle dam on the left side close to the main dam;
- Site C, a site downstream of the pre-feasibility site (Site B) identified during the pre-feasibility study. This site has an area on the left bank which can be used for a spillway and was not evaluated in detail during the feasibility study.

Photographs of the sites are shown in **Appendix A**.

2.2 BALANCING DAM

2.2.1 Dams required for balancing

The transfer scheme is positioned to transfer water in gravitation from the Site A position towards Umlaas Road via a water treatment plant – that is without a second pumpstation on route. This layout has the lowest present value cost and is recommended for implementation in the report *Task 5.1: Optimisation of Conveyance system report* and is shown in **Figure 2.4**. The lowest draw down level for balancing dams is level 872 masl - the full supply level of the existing Baynesfield Dam. The full supply level for the balancing is 897,2m – refer to *Task 5.1 Optimization of Conveyance System report*.

Operational requirements for inspection and maintenance of long transfer tunnels, like the Lesotho Highlands Transfer scheme, include the provision of balancing dams on the downstream side. These dams store water for the supply during down time periods required for inspection and maintenance periods of the tunnels, also if they

are concrete lined. The proposed uMkhomazi scheme allows for the transfer of water through a 32km long tunnel under gravity into the Umgeni Water's '57 pipeline which supplies eThekwini Municipality Western Aqueduct. It is therefore necessary that storage is provided for three weeks average supply associated with the yield of the scheme. The required balancing storage volumes for the two phases are as follows:

- Phase 1: Smithfield Dam: 7,2 million m^3;
- Phase 2: Smithfield and Impendle Dam: 14.4 million m^3.

Two layout options for the Balancing Dams were investigated in more detail:

- Option 1, a new Baynesfield Balancing Dam with storage volume 14,4 million m^3, about 1 km downstream of the existing Baynesfield Dam, of which the reservoir is located to miss the electricity power lines on the left bank and a new Mbangweni Balancing Dam with storage capacity 7,2 million m^3, about 1km downstream of the existing Mbangweni Dam. This existing dam will also be inundated by the new dam.
- Option 2, one Baynesfield Balancing Dam with storage volume 21,6 million m^3 located about 2 km downstream of the existing Baynesfield Dam.

Photographs of the existing Baynesfield Dam are included in **Appendix B**. This dam cannot be raised due to the spillway concrete A frame situated on soil and associated settlement problems.

Photographs of the Mbangweni Dam are included in **Appendix B**.

Comparison of the valleys and required dam embankments indicated that Option 2, with the one balancing dam at Baynesfield Dam, has the lowest embankment volumes by far. Option 2 was therefor considered in detail in this report. Option 1 can be considered in further optimization exercises when necessary.

The layout of the two options of balancing dams is shown on **Figure 2.2** and **Figure 2.3**.

Depending on the acceptance of the recommendations made in the report of *Task 5.1* the balancing volume requirement could change. If the twin tunnel option is accepted a balancing storage of only 13, 4 million m^3 (7,4 m^3/s) will be required, based on the ultimate yield of the scheme. However, as an initial process a required balancing volume of 21,6 million m^3 was used to position the balancing dam.

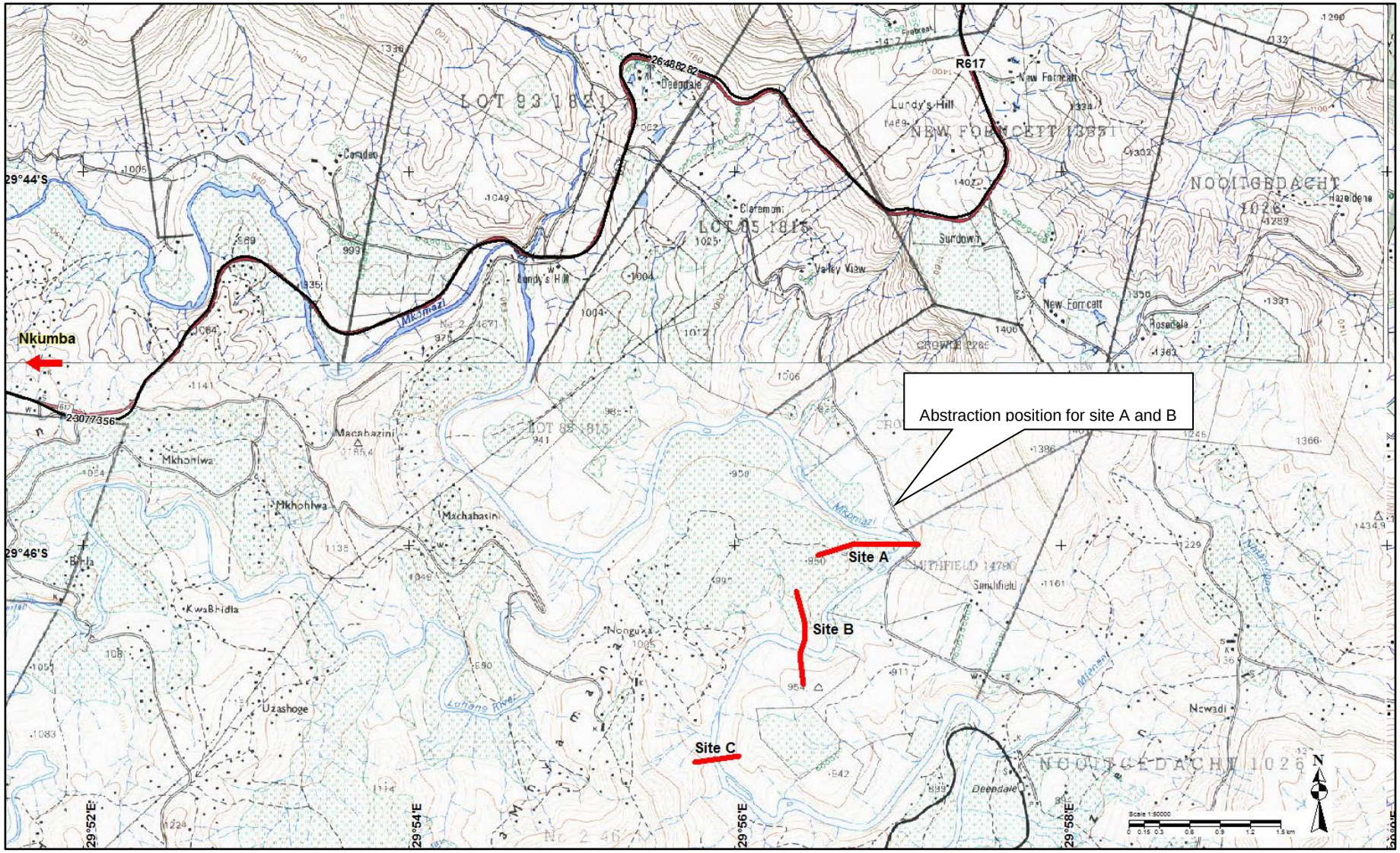

Figure 2.1: Smithfield Dam: Location of Alternative Sites

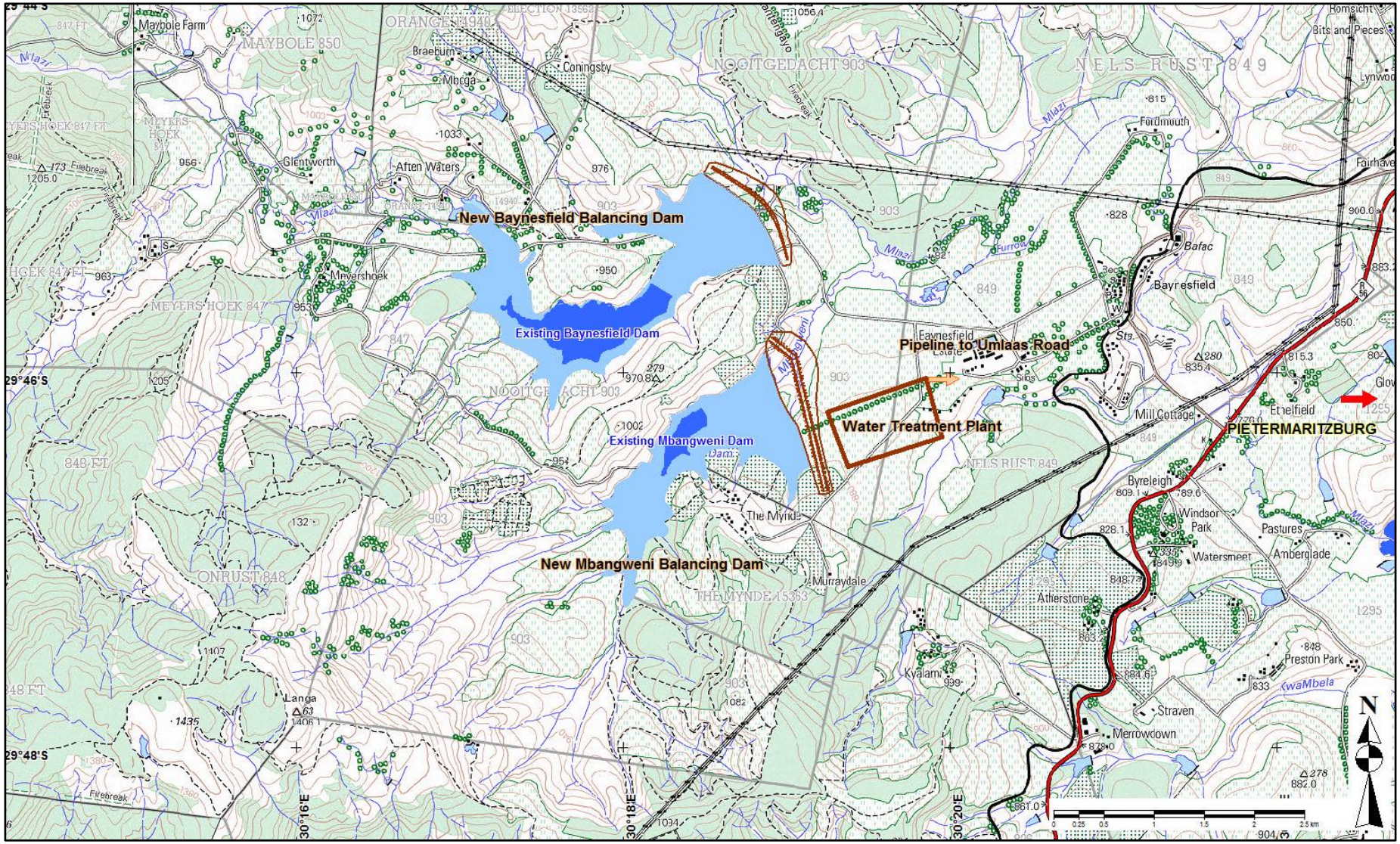

Figure 2.2: Location of Option 1, Balancing Dams

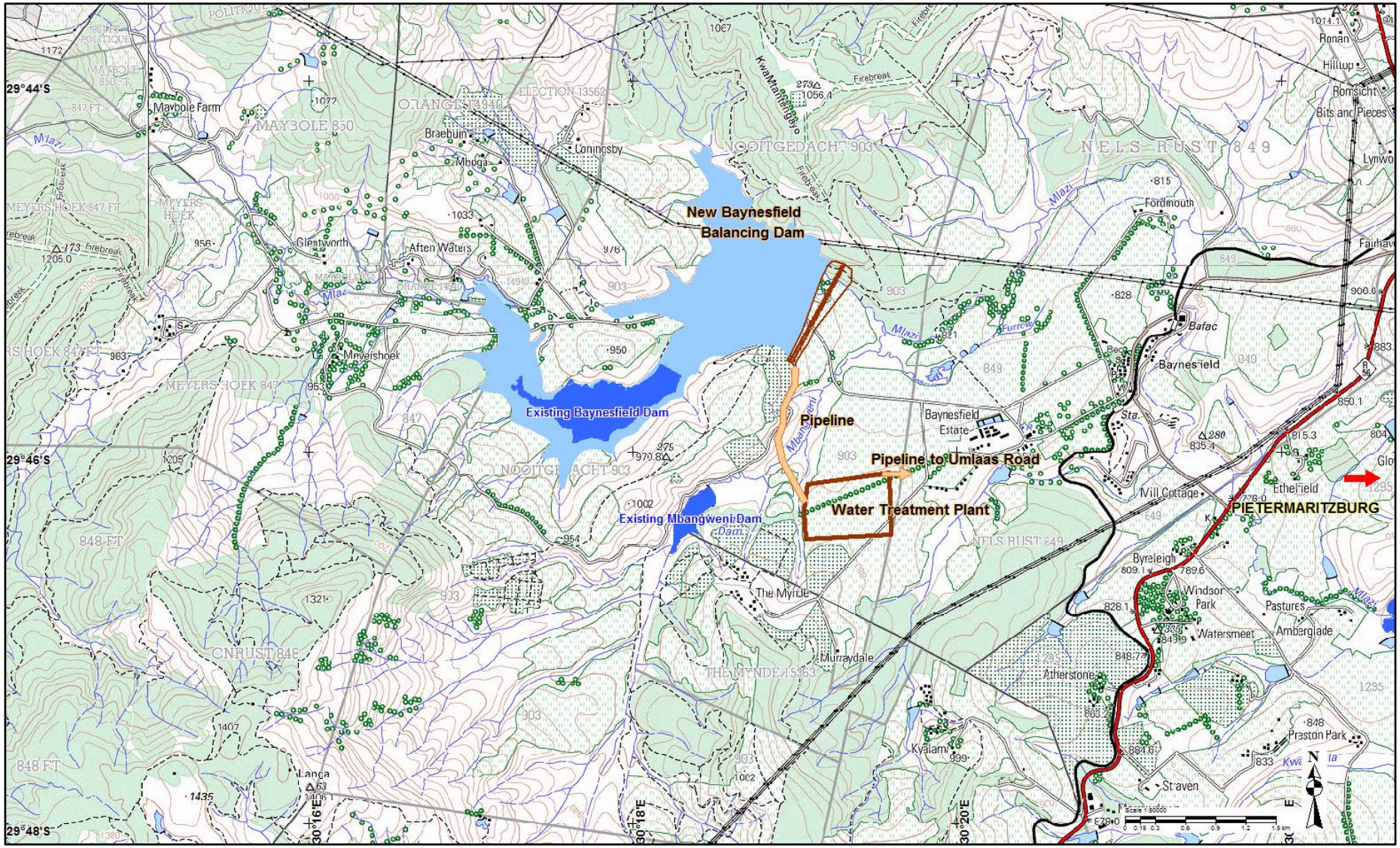

Figure 2.3: Location of Option 2, Balancing Dams

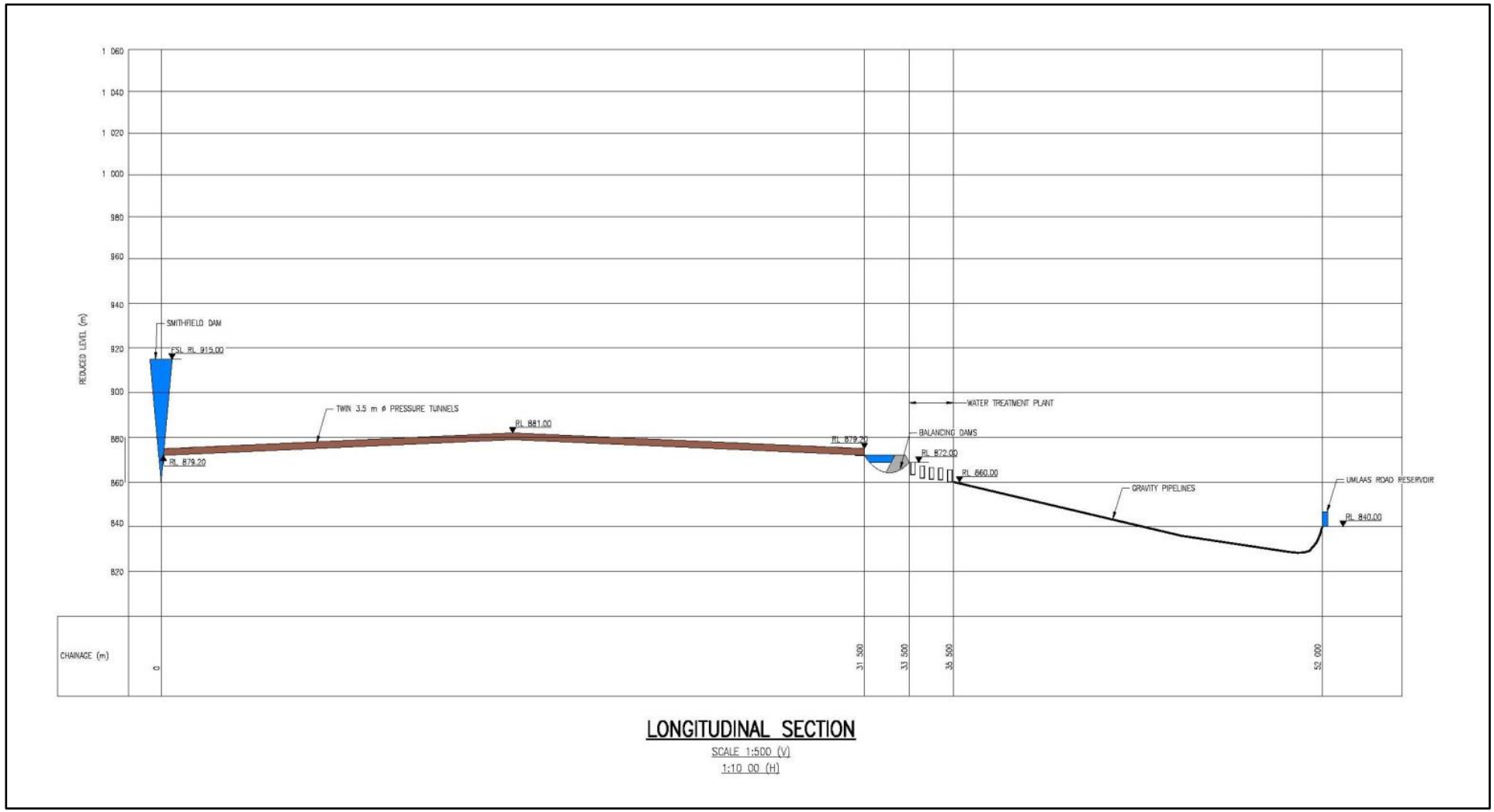

Figure 2.4: Longitudinal section through conveyance system

3 SIZING OF DAMS

3.1 SMITHFIELD DAM

The pre-feasibility study full supply storage volume of 137 million m^3 was taken as norm for sizing the reservoirs of all options. It was assumed that this capacity would result in the same yield from the dams. This assumption should be re-considered during detail yield analyses. The storage volumes characteristics of the new sites have been determined from the detail contour surveys obtained from DWA for sites A and B. For site C, 1:50 000 topographical maps were used.

The full supply levels for the dams are indicated in **Table 3.1**:

Table 3.1: Full supply levels for 137 million m³ storage volume

Smithfield Dam Option	FSL (masl)
Site A	921
Site B	915
Site C	909

The pre-feasibility study indicates that for a capacity of 137 million m³ the full supply level is at 915 masl. A re-calculated curve for Site B Smithfield Dam is included in **Appendix C**. From this curve it can be concluded that the capacity of 137 million m³ at a level of 915 masl is accurate.

3.2 BALANCING DAM

Stage / storage volume curves for the two considered options are included in **Appendix D**. The required storage volumes between the levels 879,2 and 872 masl for the two options can be obtained as shown in **Table 3.2**:

Table 3.2: Storage volumes per Balancing Dam

Balancing Dam Option	Storage Volume above 872 masl (Million m^3)
New Baynesfield Balancing Dam and new Mbangweni Balancing Dam – Option 1	11+10,6
New Baynesfield Balancing Dam – Option 2	21,6

4 FLOOD AND FLOOD ATTENUATION

4.1 SMITHFIELD DAM

4.1.1 Philosophy

In accordance with SANCOLD's *Guidelines on Safety in Relation to Floods* , the spillway at Smithfield Dam (Category III dam – large size and high hazard rating) should be capable of discharging a recommended design flood (RDF) equal to the 200-year flood with adequate "dry" freeboard and without any damage to the dam. It is furthermore required that the spillway and the dam must be able to discharge and accommodate the safety evaluation flood (SEF) with zero "dry" freeboard and accepting damage to the dam, but not with a catastrophic failure. The SEF is determined as the regional maximum flood (RMF) for the adjacent region with a numerically one step higher factor ($RMF_{+\Delta}$).

The flood peaks recommended by the DWA Directorate Hydrological Service as included in the Pre-feasibility study report are shown and compared with the Feasibility (this study) determined flood peaks in **Table 4.1**:

Table 4.1: Pre-feasibility and feasibility flood peaks

Flood peak description	Pre-feasibility Flood Peaks (m^3/s)	Feasibility Flood Peaks (m^3/s)
100 year	1 750	1 750
200 year	2 540	2 540
RMF	4 500 (k=5)	5 200 (k=5.2)
$RMF_{+\Delta}$	5 200 (k=5,2)	6 960 (k = 5,4)

The safety evaluation flood peak for this dam is taken as 6 960 m^3/s.

4.1.2 Spillway Discharge

Various spillway discharges associated with various spillway widths for ogee weir spillways were considered. Discharges for 130m wide and 160m wide spillway widths are shown in **Table 4.2**:

Table 4.2: Spillway Discharges

Stage (masl)	Flood (m^3/s)	
	130m wide spillway	160m wide Spillway
915 (FSL)	0	0
916	278	342
917	787	968
918	1 446	1 779
919	2 226	2 739
920	3 110	3 828
921	4089	5132
922	5152	6341
923	6295	7748

Discharges from these two spillway widths were used to assess flood attenuation.

4.1.3 Flood hydrograph

The SEF hydrograph was derived from the 1:200 year hydrograph proposed by the DWA as shown in report by Ninham Shand. The hydrograph with a peak of 6 960 m^3/s is shown on the figure included in **Appendix F**.

4.1.4 Stage area storage volume

The stage storage volume relationship is shown on the figure included in **Appendix C**. This graph was determined from the 1 m contour interval surveys done by the DWA.

4.1.5 Flood attenuation results

Flood attenuation calculations have been determined using the Flood 2 computer programme and the results are shown in the figure included in **Appendix F**.

From the table it is clear that the attenuation is insignificant – in the order of 3%.

It has therefore been assumed for all dam site positions that:

- Flood attenuation for the safety evaluation flood is insignificant for all the dam positions;
- That the spillway crest must be 160 m wide; and that
- A calculated freeboard of 8 m is allowed.

4.2 BALANCING DAM

4.2.1 Philosophy

The existing Baynesfield Dam is classified as a Category II dam and has a storage volume of 1,8 million m^3. The proposed new Baynesfield Balancing dam wall will be 44 m high and therefore classify as a large dam. As the dam wall is more than 30 m high and the potential loss of life is more than 10 people the hazard potential is high and thus the proposed dam will be classified as a Category III dam. The design was based on this category.

4.2.2 Flood hydrology

The catchment area of the new Baynesfield Balancing Dam (103 km^2) is attached as **Appendix E** and the time of concentration determined with the longest flow path and 10-85% slope is 2,8 h.

It is required that for a Category III Dam the recommended design flood be the 1:200 year and the SEF should be the $RMF_{+\Delta}$. The 1:20 year flood is required to be accommodated for river diversion purposes for rockfill embankments. These floods were determined with the methods and results indicated in **Table 4.3**.

Table 4.3: Peak flood (m^3/s)

Method	Recurring Interval/method				
	1:20	1:50	1:100	1:200	RMF+delta
Rational	529	707	890		
Alternative	685	906	1099	1244	
Unit Hydrograph	284	412	546		
SDF	366	554	713	883	
Empirical	247	342	432	841	
TR137		513	666	841	1769

In relation to the values in **Table 4.3**, the recommended flood peaks are indicated in **Table 4.4**.

Table 4.4: Recommended flood peaks (m³/s)

Flood peaks for recurring interval/method		
1:20	1:200 (RDF)	SEF
422	999	1769

4.2.3 Flood Hydrograph

With the calculated time of concentration (Tc), a triangular flood hydrograph was utilised to simulate the inflow flood to the new Baynesfield Balancing Dam. The total storm duration was approximated as 3 x Tc.

4.2.4 Flood attenuation

The stage-area-capacity curve was determined from 1:50 000 topographical maps (20 m intervals) and is attached in **Appendix D**. With the Muskingum routing method the flood attenuation was determined for the RDF and SEF peak floods. The results of the calculations are indicated in **Table 4.5** and attached as **Appendix G**:

Table 4.5: Flood attenuation results

	Peak Flood (m³/s)	Routed flow discharge (m³/s)	Raising of water level (m)
RDF	999	587	2,79
SEF	1 769	1 146	4,19

4.2.5 Freeboard

Freeboard was determined according to the Interim Guidelines on Freeboards for Dams (1990). The following assumptions were made in order to calculate the freeboard:

- Design wind direction perpendicular to the dam wall;
- Upstream embankment slope as 1:1,75;
- Rockfill embankment;
- Surges and seiches as 0,5 m.

The combination of RDF, the 25 year event, wind setup and flood surges and seiches had the highest freeboard requirement of 4,4 m.

4.2.6 Embankment Level

The attenuated SEF level provides for a 4,2 m freeboard. The freeboard calculated from the methodology described previously provides a larger freeboard requirement as the SEF level. The freeboard of 4,4 m is therefore adopted. This freeboard added to the FSL of 879,2 masl gives 883,6 masl. The NOC (non-overspill crest) of the embankment should be placed at 883,6 masl. As the river bed level is at 840 masl the embankment height equals 43,6 m. With a 1 % settlement allowance the Non Overspill Crest (NOC) calculates to a level of 884 masl.

5 SPILLWAY AND CHUTE SIZES

5.1 SMITHFIELD

Research indicate that for effective energy absorption the unit discharges for the chutes sized from an ogee weir or side channel spillway should conform to the unit discharges indicated in Table 5.1.

Table 5.1: Unit discharges for chute spillways

Type of chute	Maximum unit discharge selected ($m^3/s/m$)
Stepped spillway (RCC gravity structure)*	40
Chute Spillway	100

*The stepped spillway methodology has been developed for the de Hoop Dam with the aid of small triangular blocks.

For large spillways with air entrainment the higher value is used as a maximum. Chute sizes have therefore been sized as shown in Table 5.2.

Table 5.2: Selected chute widths

Type of chute	Chute width (m)
Stepped spillway for gravity structures	160
Chute Spillway	68

The invert levels of the side channel spillways were calculated with the method as described in the *Design of Small Dams* and with the selected chute width as indicated in Table 5.2 the wall heights of the chutes were determined for the SEF.

5.2 NEW BAYNESFIELD BALANCING DAM

A spillway length of 60 m and a chute width of 20 m were adopted within the limits of 40 and 100 $m^3/s/m$. The required chute wall heights were calculated with the Bernoulli equation for the SEF flood.

6 RIVER DIVERSION AND PERMANENT OUTLETS

6.1 SMITHFIELD DAM

The river diversion flood sizes were selected as follows:

- For embankment dams, the 1:20 year flood which is 1 310 m³/s as shown in the hydro report included in Ninham Shand (1999). No flood attenuation was taken into consideration.
- For concrete gravity dams, the 1:10 year flood which is 1000 m³/s.

To accommodate these floods 5 x 6m diameter tunnels with capacity 262 m^3/s each with 16m high cofferdams were selected for embankment dams and a diversion method through slots or culverts for the concrete gravity dam structures.

The permanent, Environmental Water Requirement (EWR) outlets for the two types of dams considered in this study were assumed as follows:

- Embankment dams: Two 2m diameter pipes in one tunnel originating form a multiple draw off intake structure on the upstream side of the tunnel – and access from the one tunnel.
- RCC gravity dams: Similar to the layout of Spring Grove Dam but upgraded to suit the higher head.

6.2 NEW BAYNESFIELD BALANCING DAM

The 1:20 year peak flood was calculated as 422 m³/s as indicated in **Table 4.4**. In order to accommodate this flood 2 x 6m diameter tunnels with a 12 m high cofferdam were selected.

For the irrigation requirement and the EWR, 2 x 1m diameter pipes constructed in one of the diversion tunnels were estimated. The cost of a 6m x 6m intake tower with multiple draw off upstream of the tunnel was considered.

7 DAM CONFIGURATION ARRANGEMENTS OPTIONS

7.1 SMITHFIELD DAM

7.1.1 General Layouts

The layouts described in Table 7.1 have been identified. The layouts are shown on figures as indicated.

Table 7.1: Dam Site and Type options

Dam option	Figure number
Site A: Option 1: ECRD with side channel spillway on right bank and tunnel/cofferdam diversion arrangement. Permanent Outlet through intake structure and one of the tunnels.	5
Site A: Option 2: Combined RCC gravity spillway with EED right bank.	6
Site B: Option 1: ECRD with side channel spillway and tunnel/cofferdam diversion structure on right bank and Saddle embankment. Permanent Outlet through intake structure and one of the tunnels.	7
Site B: Option 2: Central RCC spillway structure with EED flanks and Saddle embankment.	8
Site B: Option 3: ECRD with tunnel/cofferdam diversion structure, Saddle embankment and chute spillway at left side of saddle embankment. Permanent Outlet through intake structure and one of the tunnels.	9
Site C: Option 1: ECRD with side channel spillway on left bank and tunnel/cofferdam diversion structure. Permanent Outlet through intake structure and one of the tunnels.	10
Site C: Option 2: RCC Gravity Dam with central spillway	11

7.1.2 Specific arrangements

For each option two layouts associated with outlets have been considered, namely an outlet for pumping and an outlet (intake structures) to the tunnels. The layouts of the intake structures for the pumping and tunnel options are shown in Figure 7.9, Figure 7.10 and Figure 7.11. A larger intake structure is required for the pumping option which is associated with a pumphouse. No structures for the releases of instream flow requirements have been included in the analysis as these costs are common to all considered options. Furthermore, the relocation of power lines around

the reservoir is a common cost and has not been taken into consideration in the comparisons.

The deviation of the road for Site A and the longer transfer tunnel for Site C is included in the determination of the cost.

A summary of the options and specific arrangements/infrastructure are described in **Table 7.2**.

Table 7.2: Dam options and special arrangements

Dam option	Specific arrangement/infrastructure
Site A: Option 1: **ECRD with side channel spillway** on right bank and tunnel/cofferdam diversion arrangement. Permanent Outlet through intake structure and one of the tunnels	For water supply: Intake Tower upstream of one diversion tunnel, pipeline through diversion tunnel to Pump Station or tunnel. Pump Station downstream of the dam for pumping option. No pumping station for tunnel option.
Site A: Option 2: **Combined RCC gravity spillway** with EED right bank.	For water supply: Intake Tower upstream of dam, pipeline to Pump Station or tunnel. Pump station downstream of the dam for pumping option. Schematically depicted in **Figure 7.9**. No pumping station for tunnel option.
Site B: Option 1: **ECRD with side channel spillway** and tunnel/cofferdam diversion structure on right bank and Saddle embankment. Permanent Outlet through intake structure and one of the tunnels	For water supply: Intake tower to tunnel and larger intake tower with Pump Station house at site A. See **Figure 7.10** and **Figure 7.11.**
Site B: Option 2: **Central RCC spillway structure** with EED flanks and Saddle embankment.	For water supply: Intake Tower upstream of dam, pipeline to Pump Station or tunnel. Schematically depicted in **Figure 7.9**, **Figure 7.10** and **Figure 7.11**. No pumping station for tunnel option.
Site B: Option 3: **ECRD with** tunnel/cofferdam diversion structure, Saddle embankment and **side channel spillway** at left side of saddle embankment. Permanent Outlet through intake structure and one of the tunnels	For water supply: Intake tower to tunnel and larger intake tower with Pump Station house at site A. See **Figure 7.10** and **Figure 7.11.**
Site C: Option 1**: ECRD with side channel spillway** on left bank and tunnel/cofferdam diversion structure. Permanent Outlet through intake structure and one of the tunnels	For water supply: Intake tower to tunnel and larger intake tower with Pump Station house upstream of the embankment See **Figure 7.10** and **Figure 7.11.**
Site C: Option 2: RCC Gravity Dam with central spillway	For water supply: Intake Tower upstream of dam, pipeline to Pump Station or tunnel. Pump station downstream of the dam for pumping option. Schematically depicted in **Figure 7.9**. No pumping station for tunnel option.

7.2 BALANCING DAM

An Earth Core Rockfill Dam (ECRD) with the Outlet works and ogee shaped, side channel spillway on the left flank was considered. The diversion tunnels were also placed on the left flank. The transfer structure was placed on the right flank in order to facilitate the transfer to the water treatment works. The layout of the considered balancing dam is shown in **Figure 7.8**.

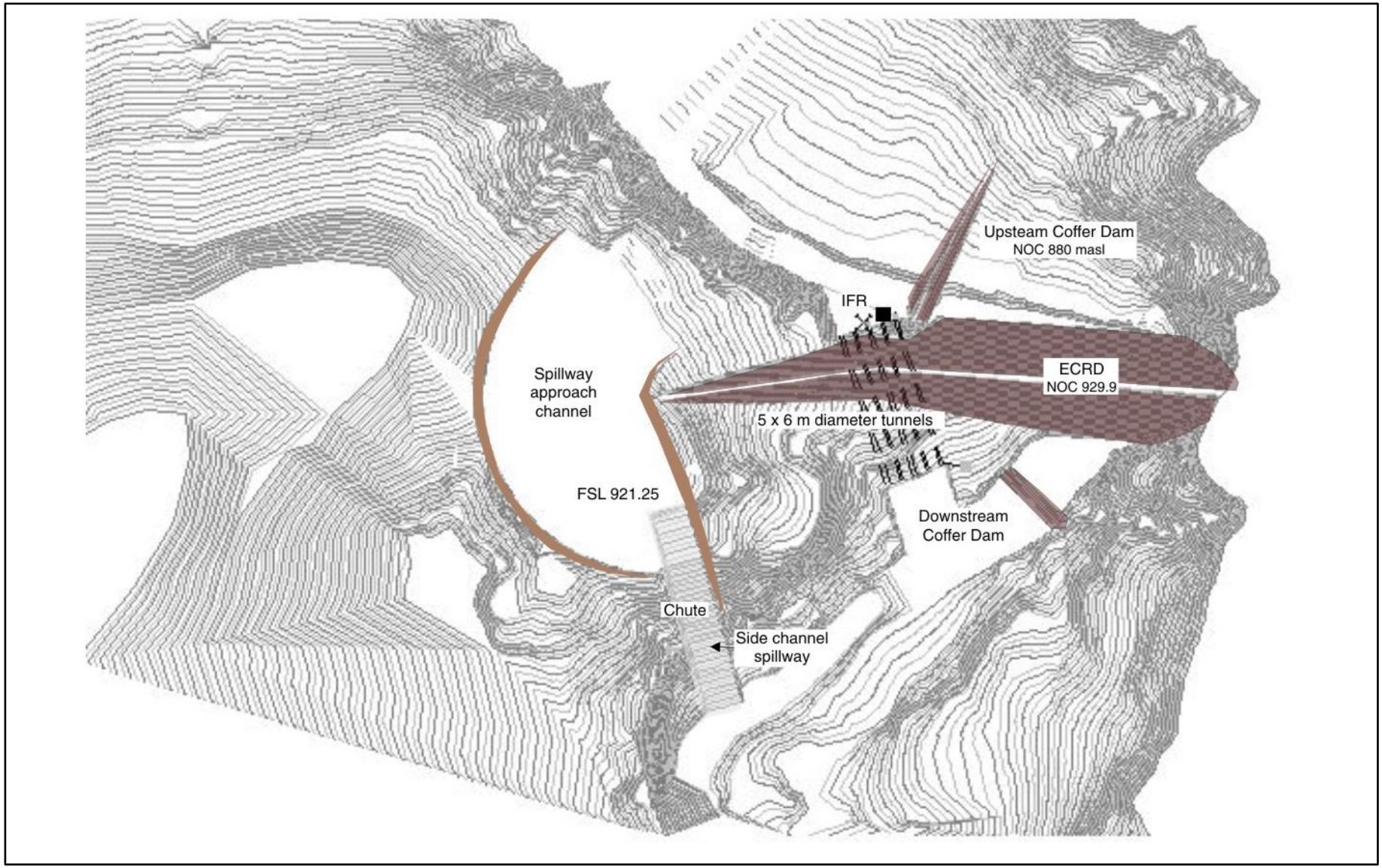

Figure 7.1: Smithfield Dam Site A, Option 1

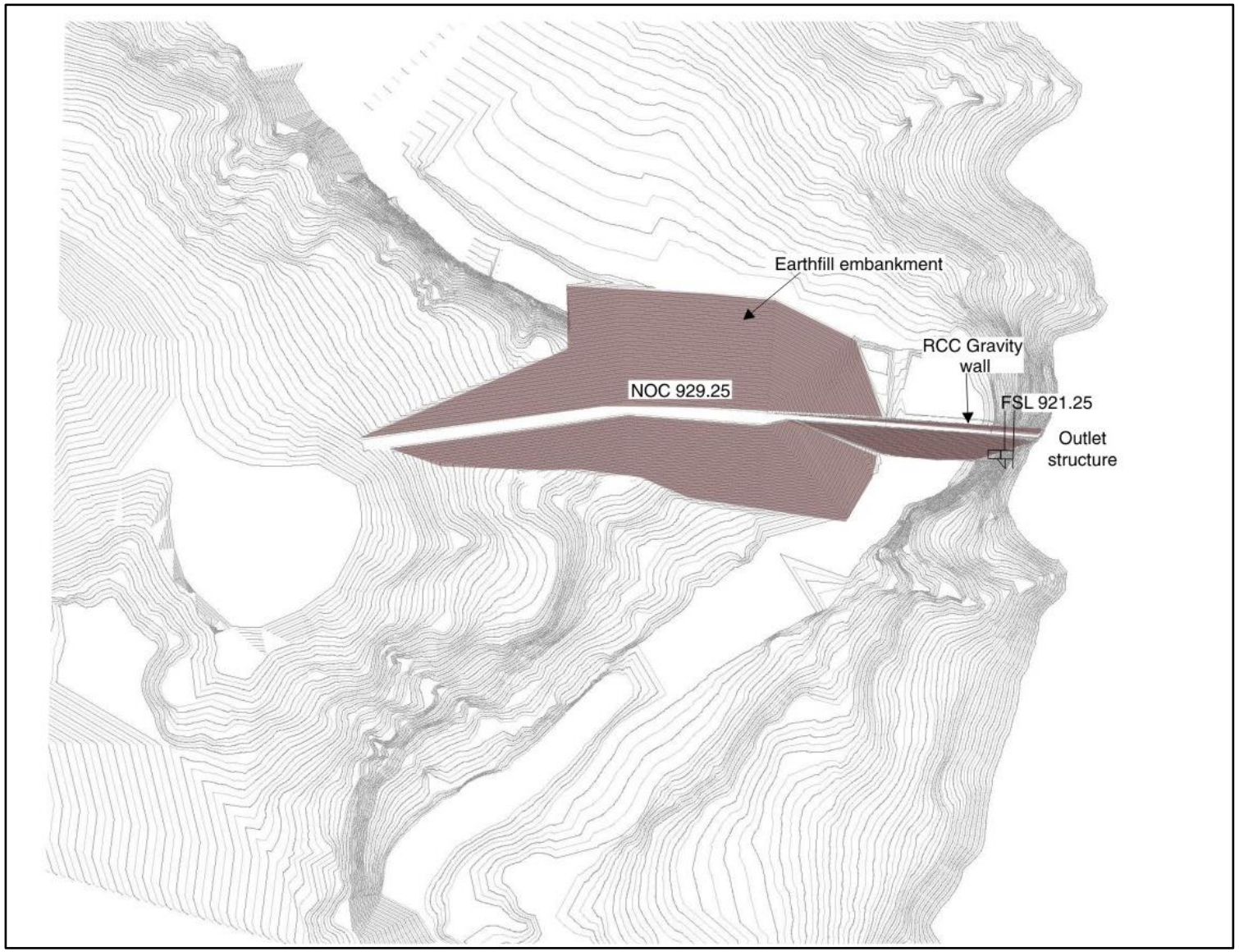

Figure 7.2: Smithfield Dam Site A, Option 2 - Dam Layout

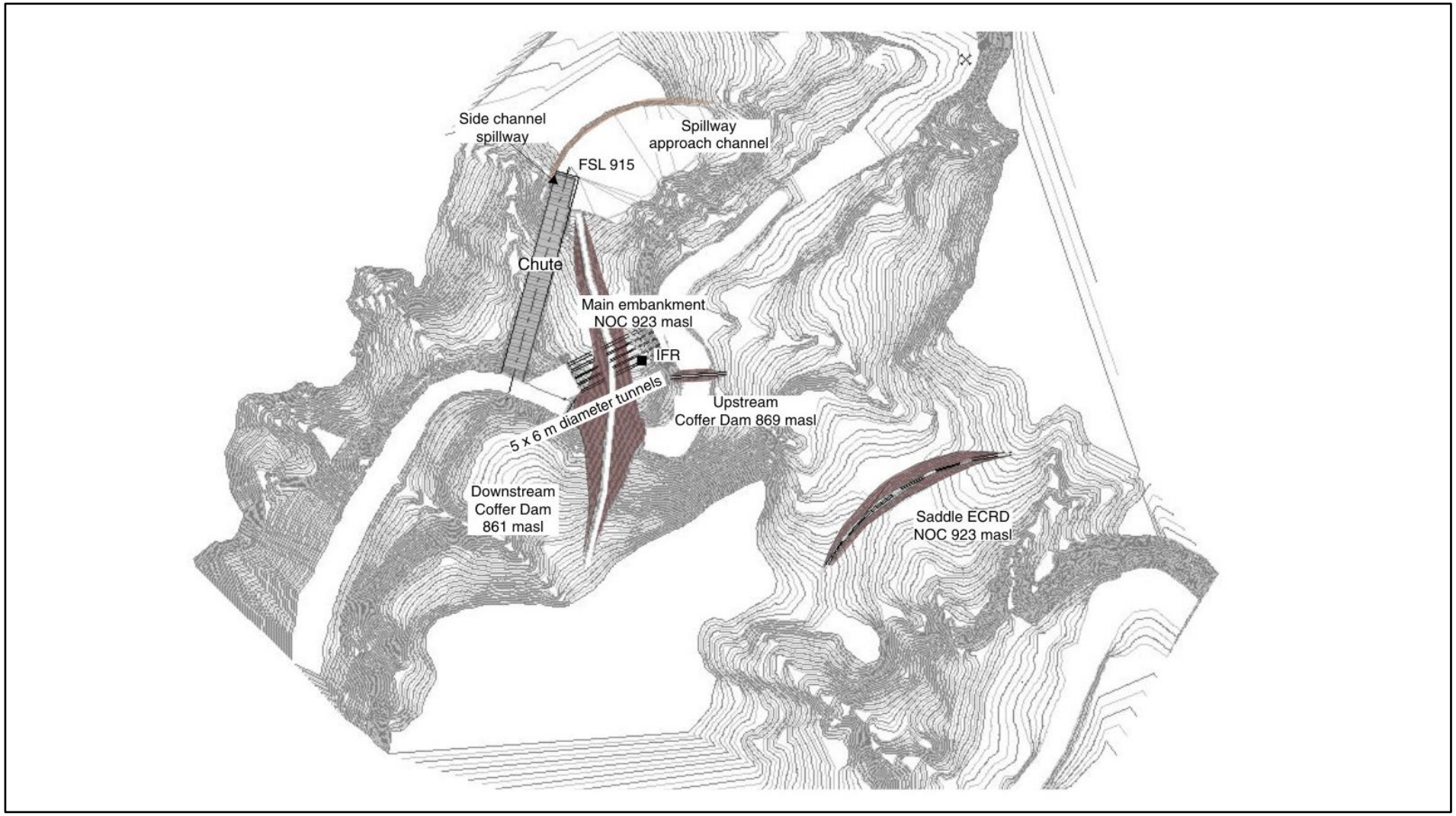

Figure 7.3: Smithfield Dam Site B, Option 1- Dam

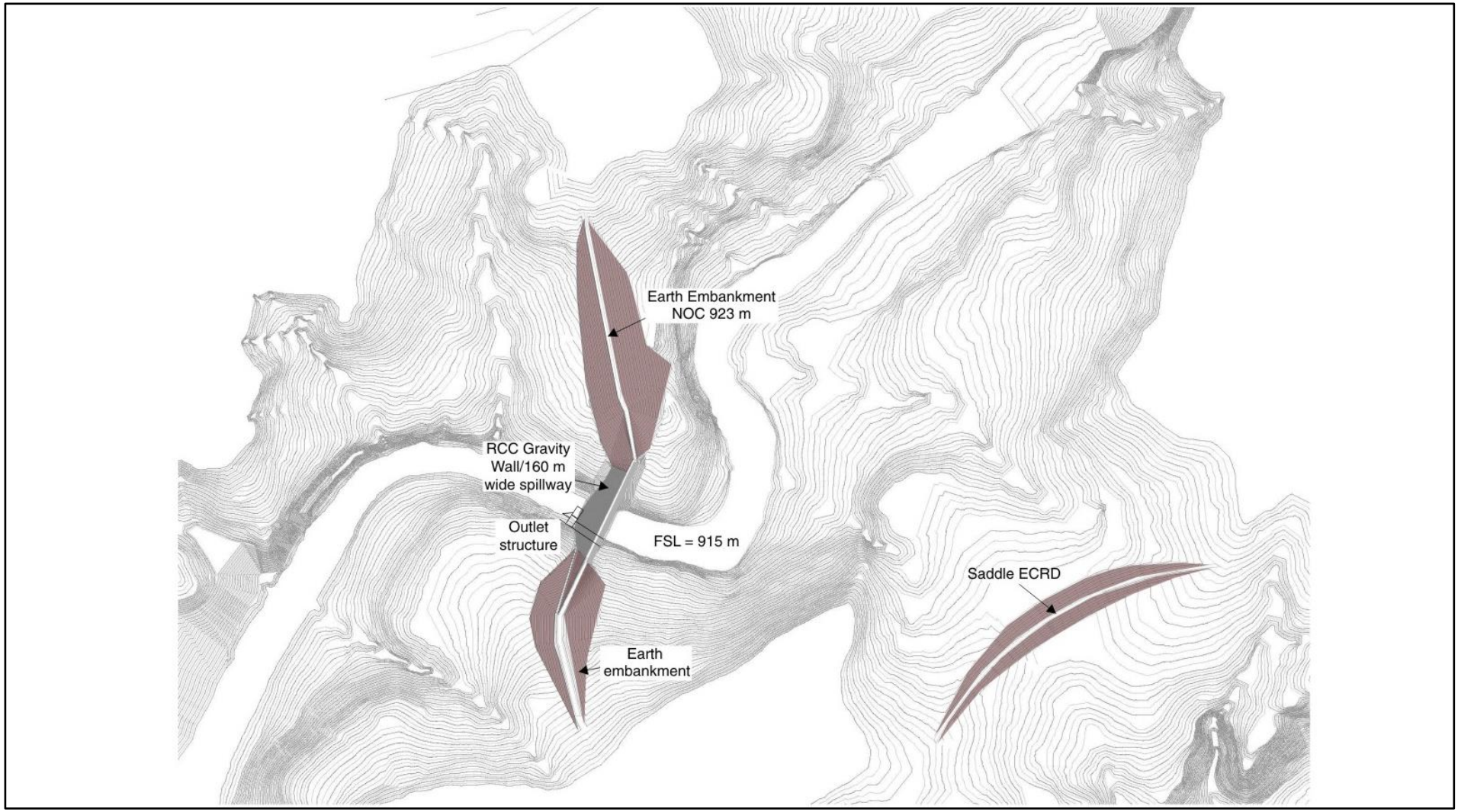

Figure 7.4: Smithfield Dam Site B, Option 2

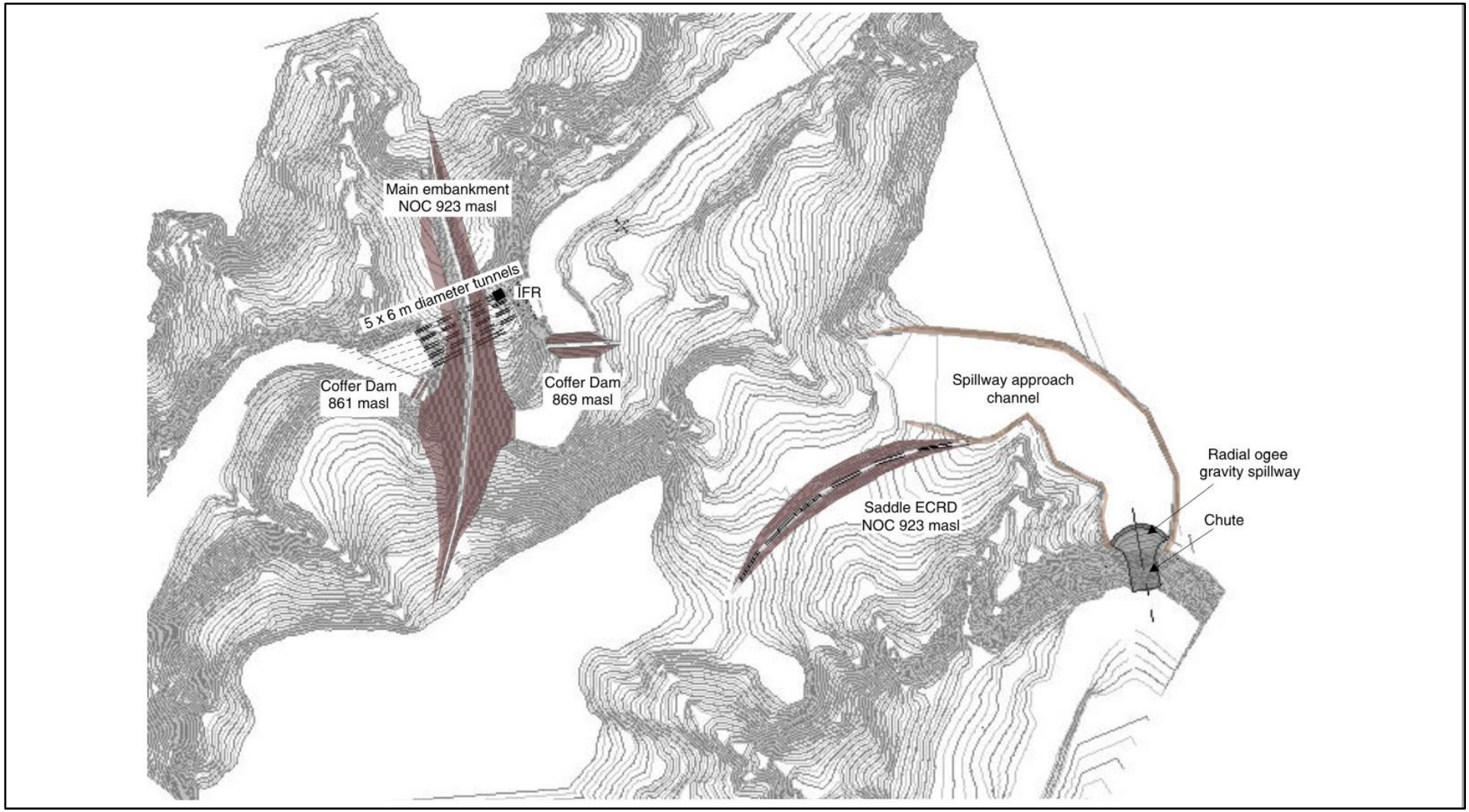

Figure 7.5: Smithfield Dam Site B, Option 3

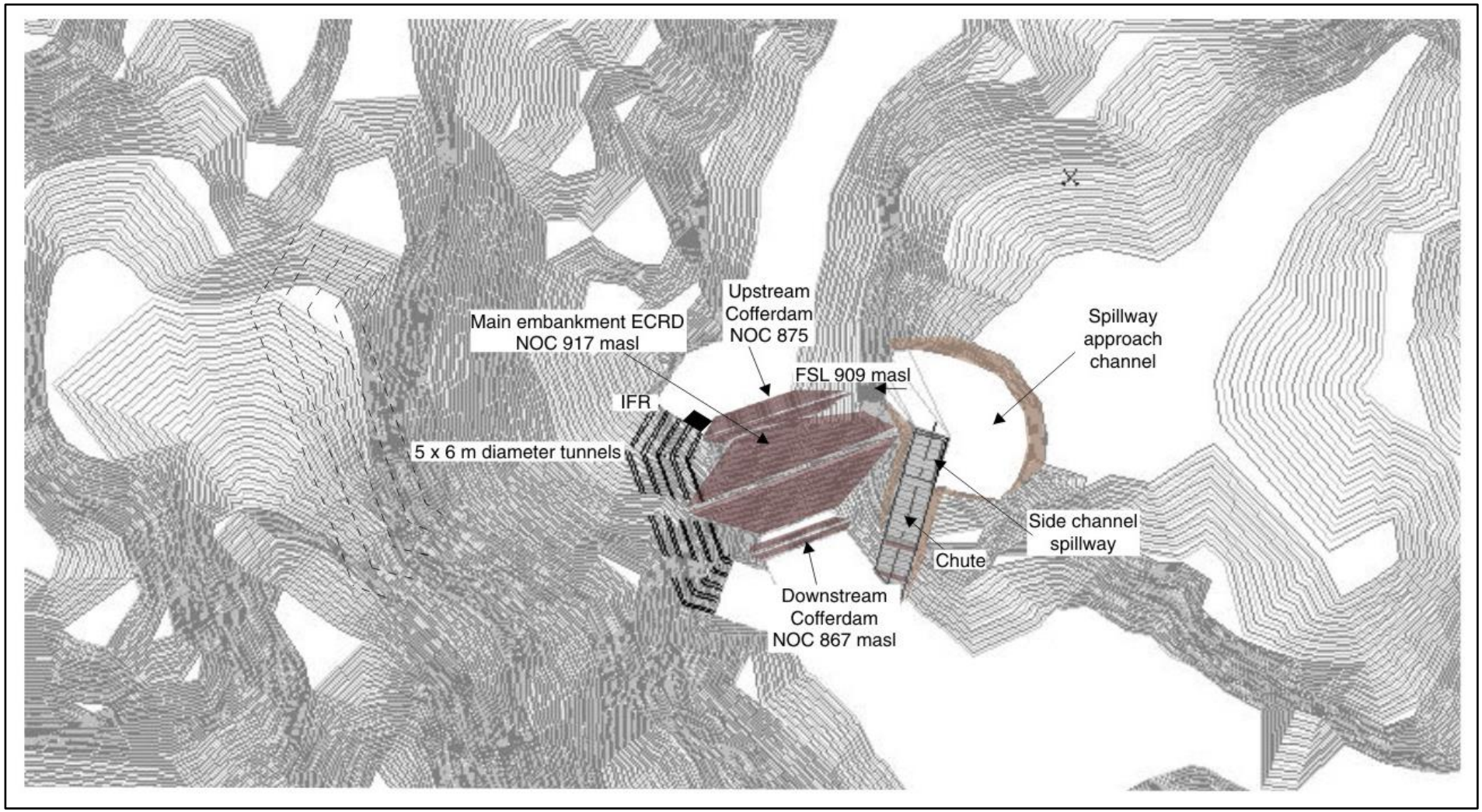

Figure 7.6: Smithfield Dam Site C, Option 1

Figure 7.7: Smithfield Dam Site C, Option 2

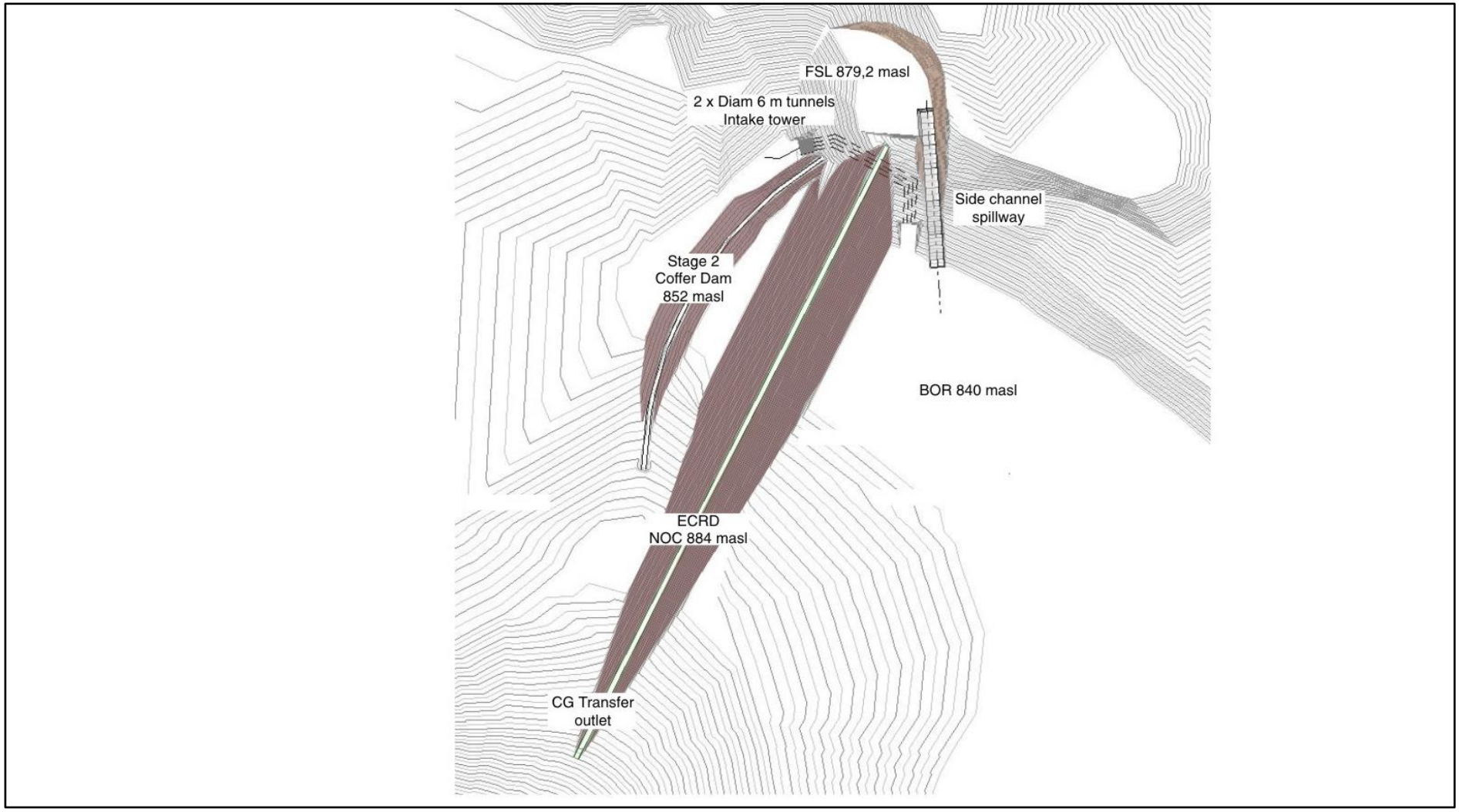

Figure 7.8: New Baynesfield Balancing Dam, Option 2

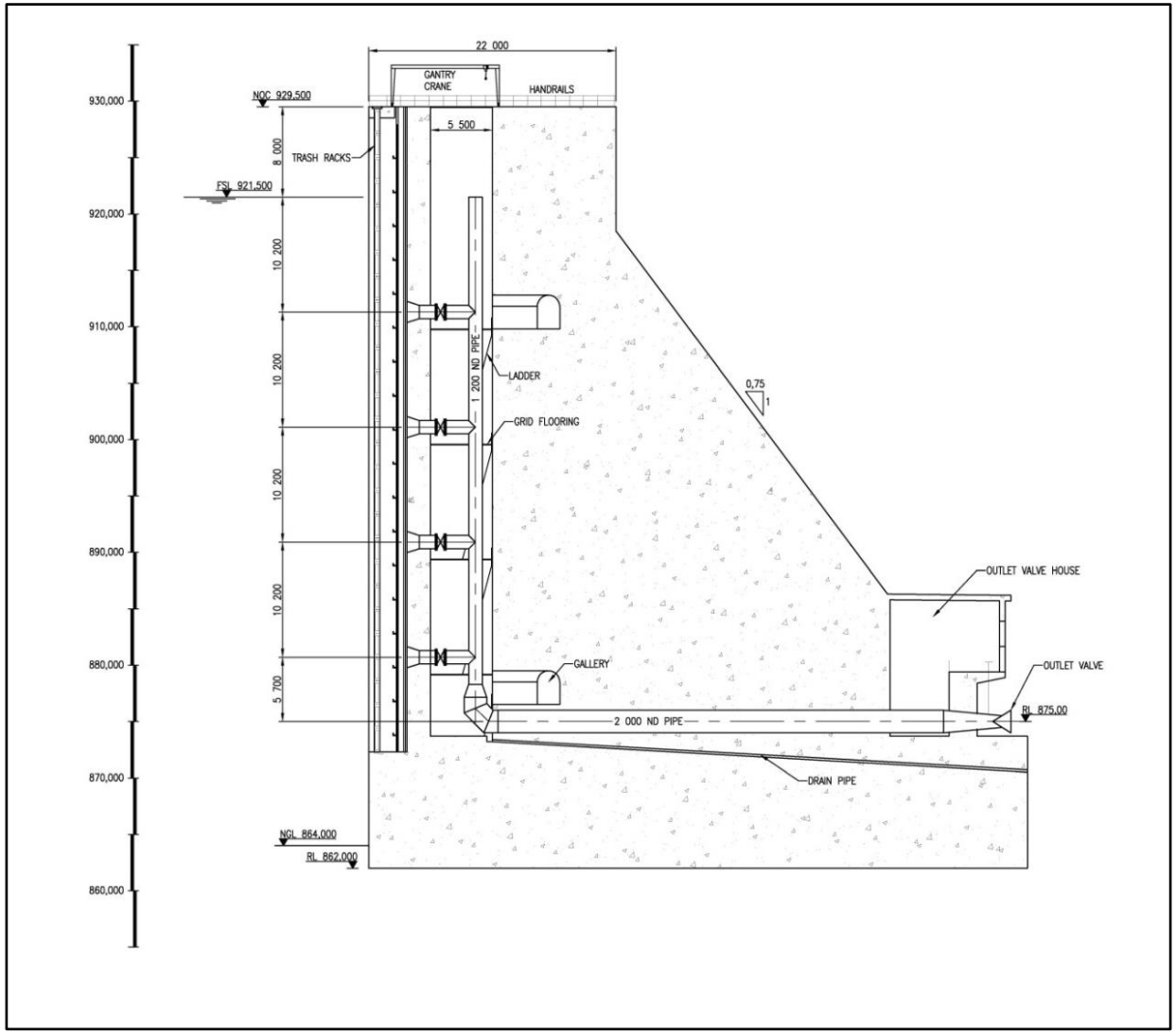

Figure 7.9: Intake tower through RCC structure

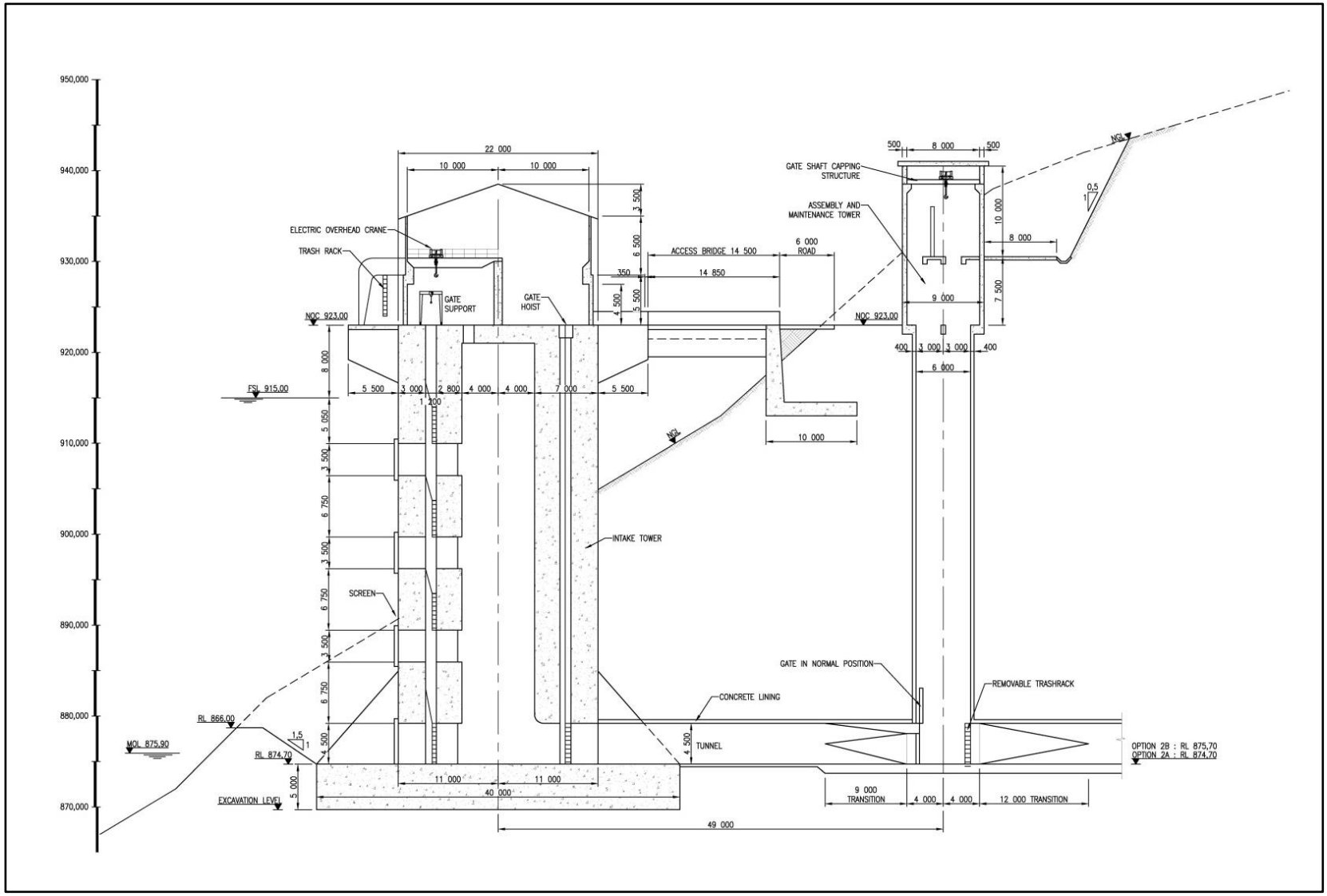

Figure 7.10: Intake tower for tunnel option

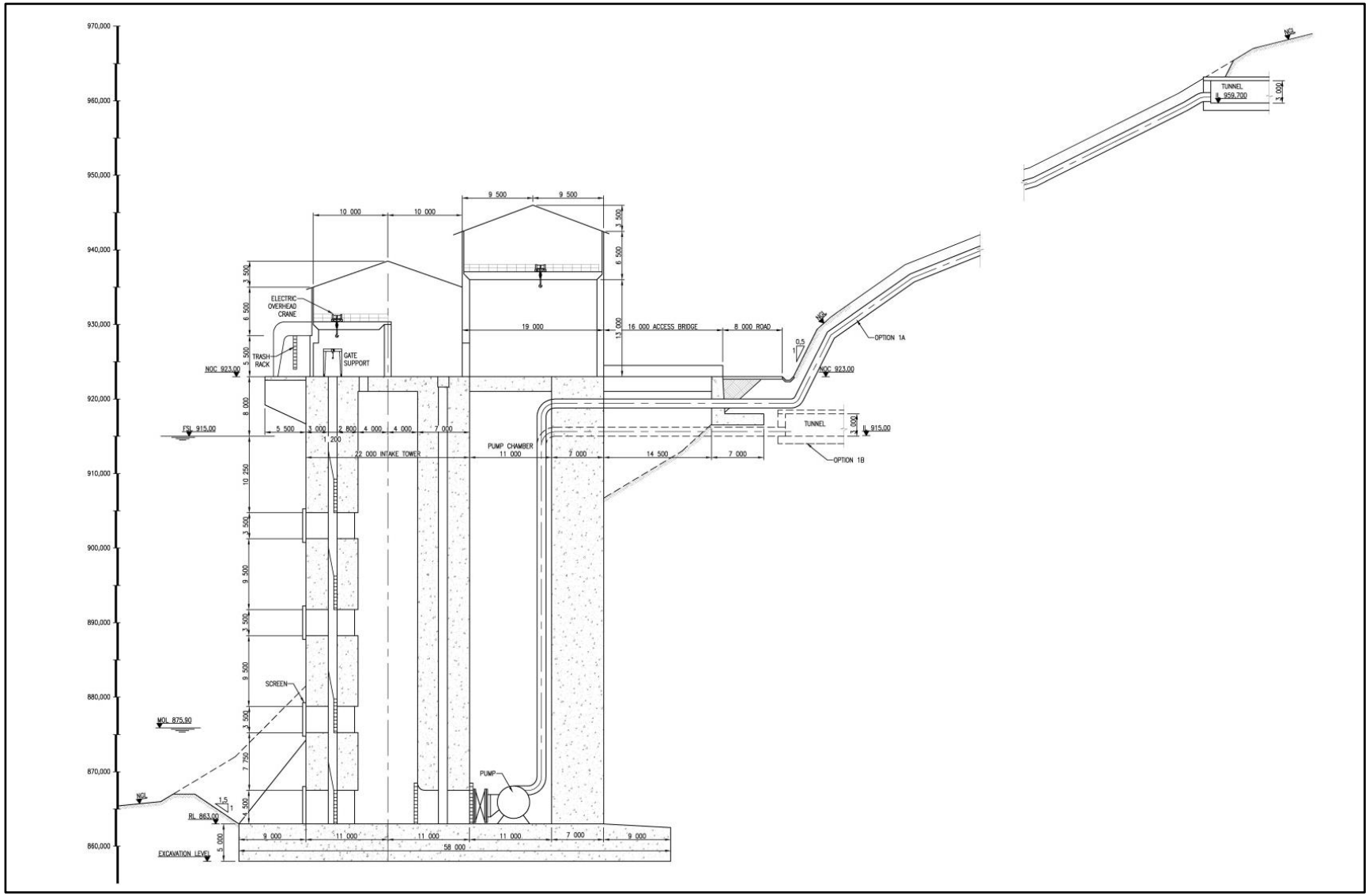

Figure 7.11: Intake tower for pump option

8 DAM CROSS SECTION LAYOUTS

8.1 SMITHFIELD DAM

Cross sections for the ECRD and the RCC gravity structures are shown in **Figure 8.1**.

8.2 BALANCING DAM

The New Baynesfield Balancing Dam was estimated with the same cross section layout as shown in **Figure 8.1**.

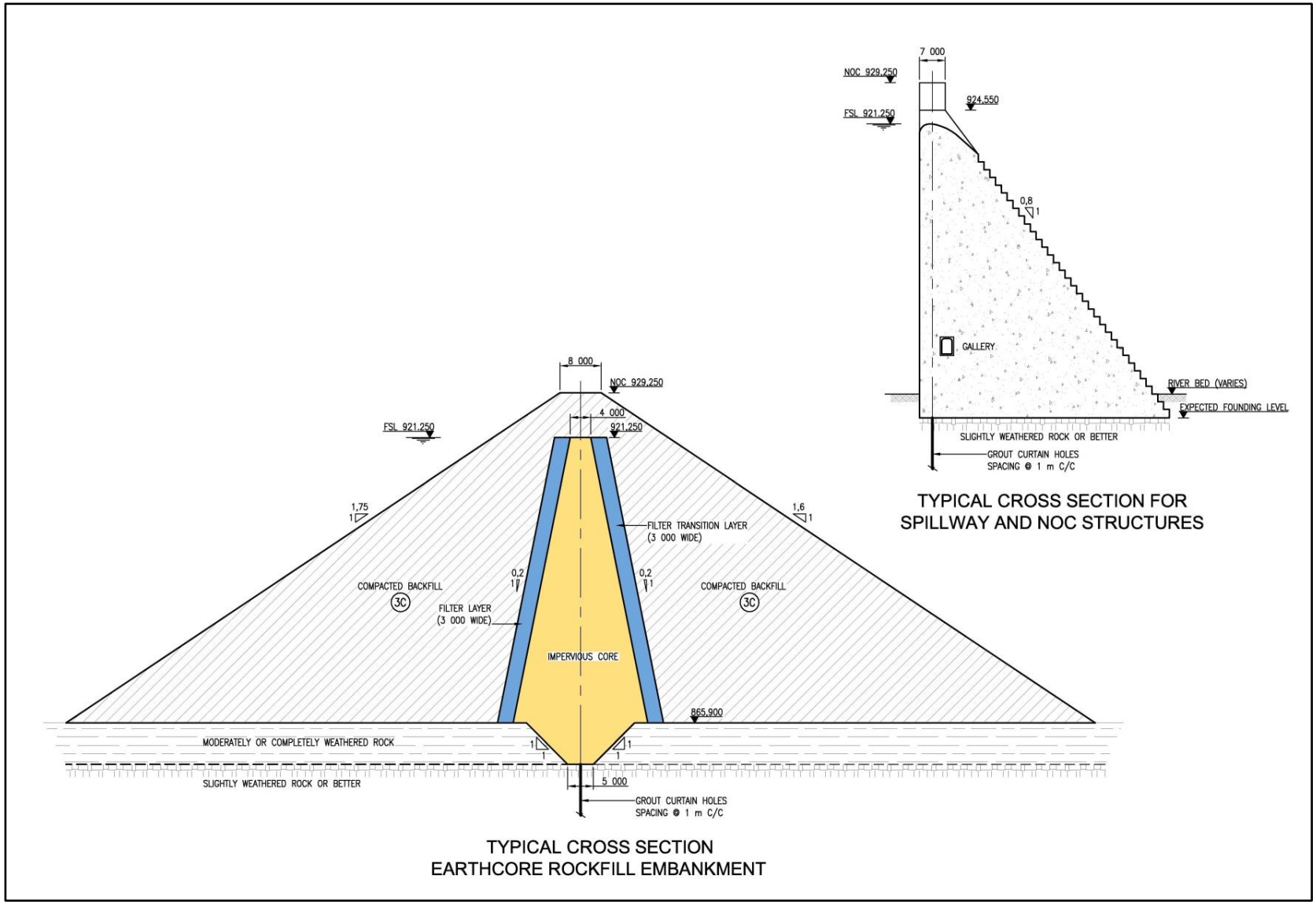

Figure 8.1: Typical cross sections of embankments

9 FOUNDATION CONSIDERATIONS

9.1 SMITHFIELD DAM SITE B

Based on Site B investigations the layout and the depths of excavation on the areas indicated are shown in Table 9.1.

Table 9.1: Depths (m) of excavation for Site B

Left Bank		River Section		Right Flank		Spillway
Siltstone Dolerite Siltstone		Siltstone		Alluvium Siltstone Dolerite Siltstone		Alluvium Siltstone Dolerite
Core	Concrete	Core	Concrete	Core	Concrete	Concrete
3 - 5	7 - 10	1 - 3	7,5	5 - 11	>13	>13

9.2 SMITHFIELD DAM SITE A

Table 9.2 shows the excavation depths assumed for Site A.

Table 9.2: Depths (m) of excavation for Site A

Left Bank		River Section		Right Flank		Spillway
Siltstone Dolerite		Siltstone		Alluvium Siltstone		Alluvium Siltstone Dolerite
Core	Concrete	Core	Concrete	Core	Concrete	Concrete
3 - 5	7 - 10	1 - 3	7,5	5 - 11	>13	>13

9.3 SMITHFIELD DAM SITE C

The excavation depths shown in Table 9.3 have been assumed for Site C.

Table 9.3: Depths (m) of excavation for Site C

Left Bank		River Section		Right Flank		Spillway
Siltstone Dolerite Siltstone		Siltstone		Alluvium Siltstone Dolerite Siltstone		Alluvium Siltstone Dolerite
Core	Concrete	Core	Concrete	Core	Concrete	Concrete
2- 4	5 - 10	2 - 3	7,5	5 - 11	>10	4 - 8

9.4 NEW BAYNESFIELD BALANCING DAM SITE

The VAPS model was utilised to determine the excavation depths. VAPS proposes that for a CFRD the footprint of the embankment should be excavated 2 m deep. The core should be excavated by a factor in relation to the height of the embankment. Therefore the core invert level was excavated a further 2 m deep, 22 m wide and with V1:H1 side slopes.

10 COST ESTIMATION

10.1 SMITHFIELD DAM

10.1.1 Dam Cost

The Schedules of Quantities (SOQ's) of the cost estimates are included in Appendices as shown in Table 10.1. Latest tender rates e.g. for Springs Grove Dam contract were used for cost estimate. A summary of the capital costs for layout for the outlet for pumping option and for supply to pressure tunnel are also shown in Table 10.1.

Table 10.1: Summary of Comparable Cost Estimates of the Dams

Dam option	Appendix where SOQ is included	Capital cost (R million excluding VAT)	
		Outlet for pumping option	Outlet for supply to pressure tunnel
Site A: Option 1: ECRD with side channel spillway on right bank and tunnel/cofferdam diversion structure.	Appendix H	1 334	1 328
Site A: Option 2: Combined RCC gravity spillway with EED right bank.	Appendix I	1 856	1 844
Site B: Option 1: ECRD with side channel spillway and tunnel/cofferdam diversion structure on right bank and Saddle embankment.	Appendix J	1 117	935
Site B: Option 2: Central RCC spillway structure with EED flanks and Saddle embankment.	Appendix K	1 575	1 384
Site B: Option 3: ECRD with tunnel/cofferdam diversion structure, Saddle embankment and chute spillway at left side of saddle embankment.	Appendix L	999	817
Site C: Option 1: ECRD with side channel spillway on left bank and tunnel/cofferdam diversion structure.	Appendix M	1 414	1 229
Site C: Option 2: RCC Gravity Dam with central spillway.	Appendix N	1 650	1 469

10.2 BALANCING DAM

Cost estimates of the Balancing Dams are included in **Appendix O** and a summary is shown in **Table 10.2**.

Table 10.2: Summary of new Balancing Dam Options

Dam option	Capital cost (R excluding VAT)
Option 2: One dam	R 887,1 million

11 CONCLUSIONS

11.1 COMPARISON OF DAMS

11.1.1 Smithfield Dam

From **Table 10.1** the following is clear:

- Site C Dams are higher in cost in relation to other options. These dams should not be considered further.
- Site B: Option 3 Dam has the lowest cost with site B: Option 1 second lowest (Sensitivity analysis on rockfill haulage for Site B: Option 3 dams concludes this same assumption).
- Site A dam options all have higher costs than site B dams.

Site A: Option 1 and Site B: Option 3 costs have been used in the *5.1 Optimization of Conveyance System Report*. The outcome of the complete conveyance system showed that Site B: Option 3 dam with a pressure tunnel is the preferred option.

11.1.2 Baynesfield Dam

Due to the proposed position of the balancing dam and the overall scheme configuration water can only be abstracted between levels 872 masl and 879,2 masl as described in the Report 5.1 Optimization of Conveyance System. In order to obtain the required 21 day balancing and deliverable height (872 masl) a very high embankment needs to be constructed. This dam has a large “dead” storage volume below 872 masl.

The following options are available and should be investigated:

- The construction of the proposed new Baynesfield Balancing Dam;
- The construction of a balancing dam at the proposed position with a FSL at 872 masl. The required abstraction could be obtained by pumping to the nearby water treatment works. However, the cost of a pump station to transfer 15 m^3/s is significant and the very irregular period of operation of the pump station will be unpractical;
- The construction of a balancing dam at Umlaas road (and water treatment plant);

- The utilization of the existing water resources and water supply infrastructure to supplement the uMkhomazi system when maintenance of the tunnel is required.

12 RECOMMENDATION FOR MATERIALS, BORROW AREAS AND QUARRIES FOR AND LAYOUT OF PREFERRED DAMS

The following are recommended:

- Smithfield Dam Site B: Option 3 be investigated for foundation and material conditions;
- The balancing dam position is re-considered, after appointment of the Umgeni Water consultant for the pipeline section of the conveyance structure to Umlaas Road reservoir;
- Phasing of the balancing dam in accordance with the size of the tunnel (one large tunnel as opposed to twin tunnels – one tunnel constructed later when required.

13 REFERENCES

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Rennie AG: *Report on Mbangweni Dam Safety Inspection*, 2011, MBB Consulting Engineers, P.O. Box 12051, Dorpspruit, 3206.

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Appendix A

Photographs of Smithfield Dam

Figure 1: Site B: View from left bank towards downstream

Figure 2:Site C: Area on left bank for spillway viewing upstream

Appendix B

Photographs of balancing dam sites

Figure 1: Baynesfield Dam: Dam viewed from the left bank

Figure 2: Baynesfield Dam: Concrete A-frame spillway with splitters

Figure 3: Baynesfield Dam: Spalled concrete on slipway due to movement

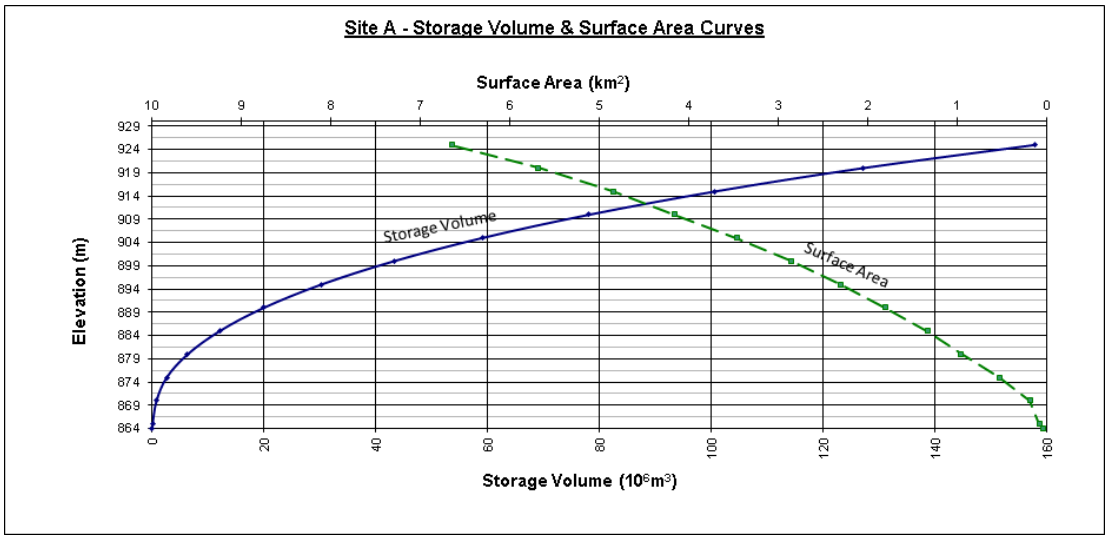
Figure 4: Baynesfield Dam: Spalled concrete on spillway due to movement of concrete structure on embankment.

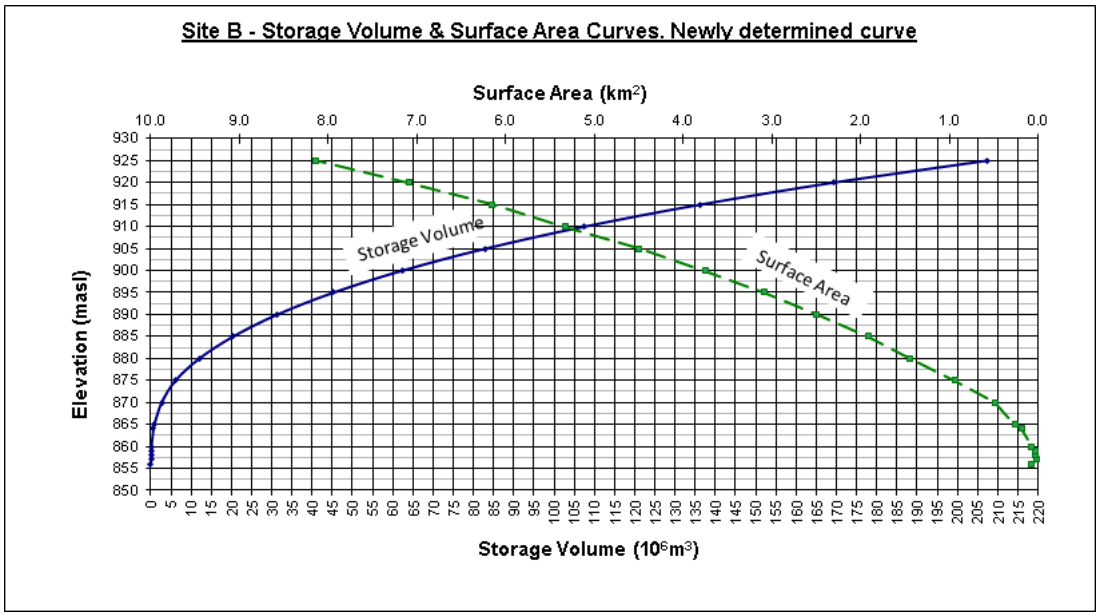
Figure 5: Mbangweni Embankment left bank

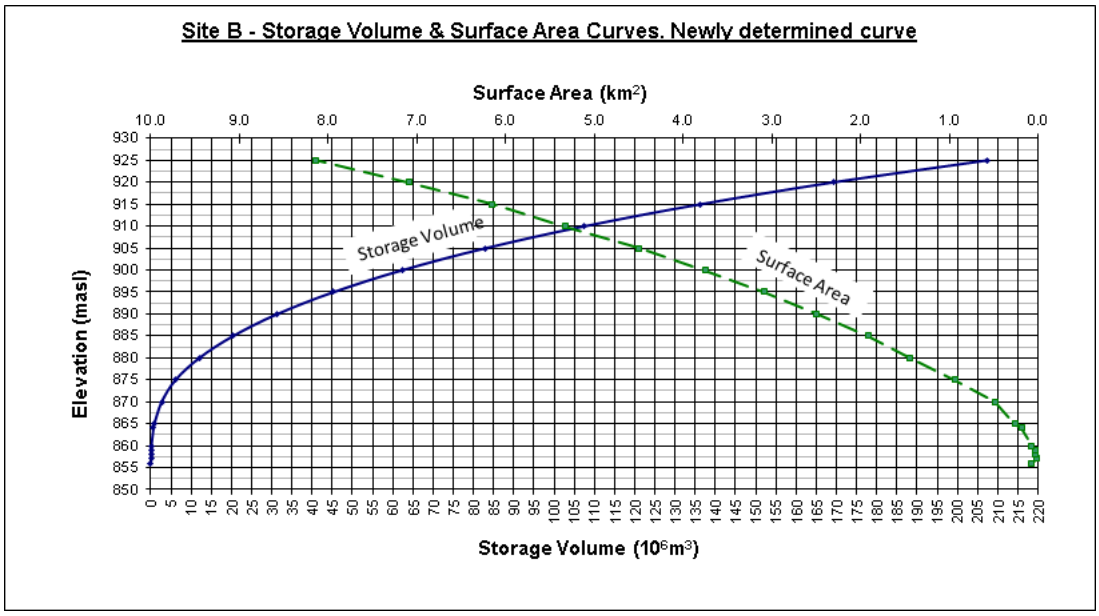
Figure 6: Mbangweni Embankment: Right Bank. Pump Station downstream of the dam

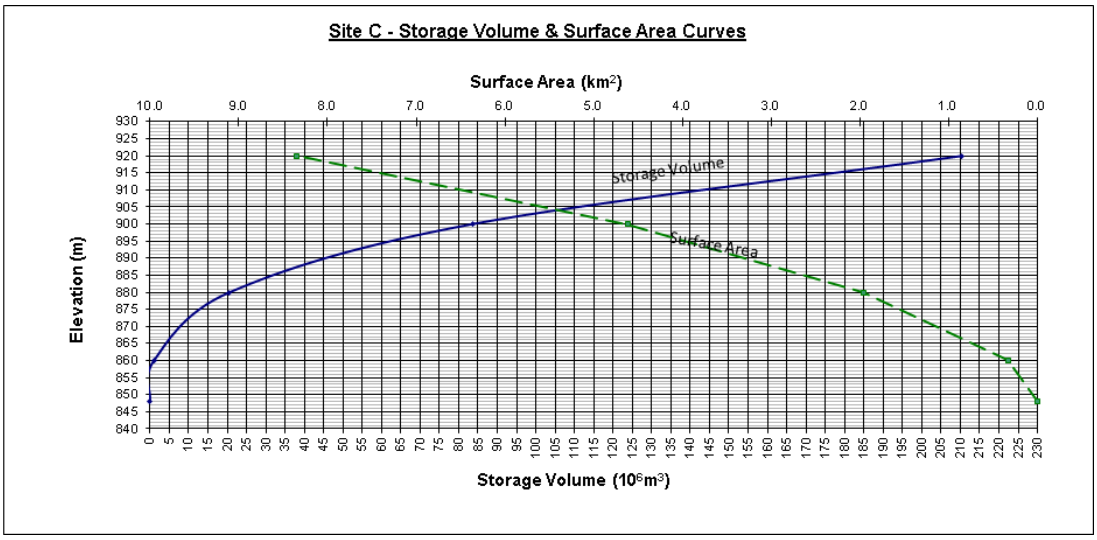
Appendix C

Smithfield Dam stage/area, volume curves


Site A - Storage Volume & Surface Area Curves
Surface Area (km²)
Elevation (m)
Storage Volume
Surface Area
Storage Volume (10⁶m³)

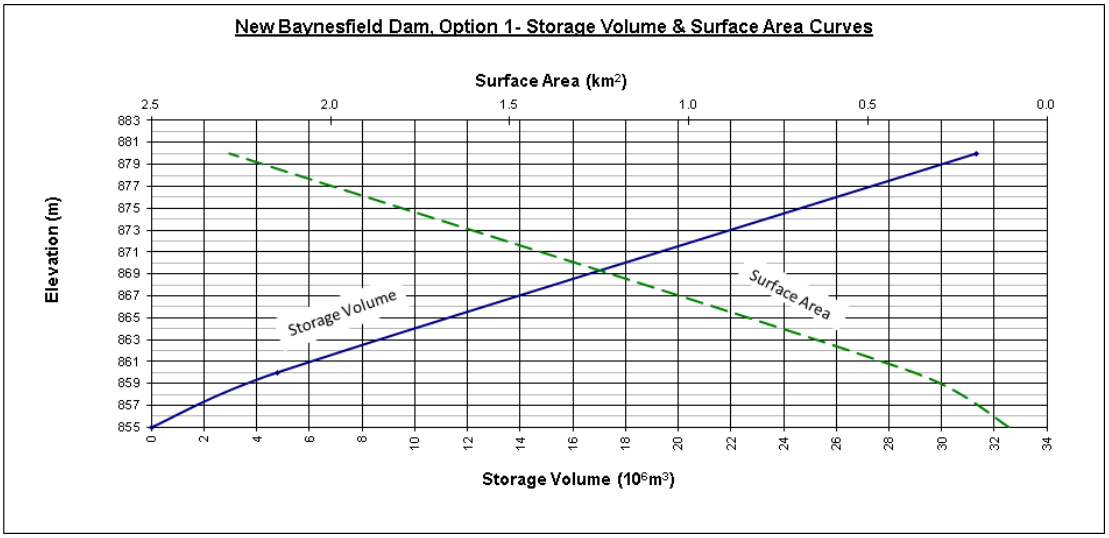

Site B - Storage Volume & Surface Area Curves. Newly determined curve
Surface Area (km²)
Elevation (masl)
Storage Volume
Surface Area
Storage Volume (10⁶m³)

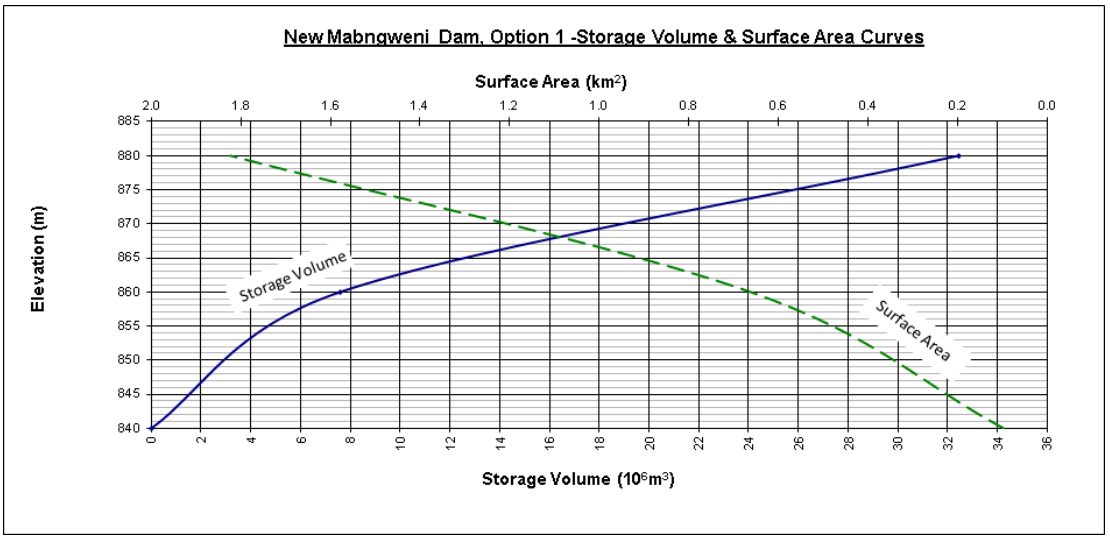

Site B - Storage Volume & Surface Area Curves. Newly determined curve
Surface Area (km²)
Elevation (masl)
Storage Volume
Surface Area
Storage Volume (10⁶m³)

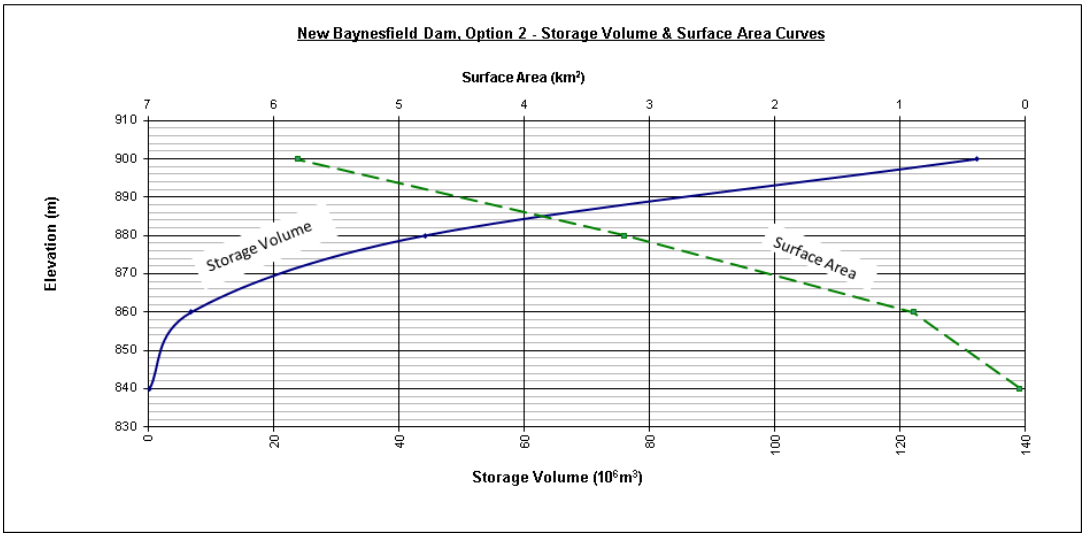

Site C - Storage Volume & Surface Area Curves
Surface Area (km²)
10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
Elevation (m)
930 925 920 915 910 905 900 895 890 885 880 875 870 865 860 855 850 845 840
Storage Volume
Surface Area
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230
Storage Volume (10⁶m³)

Appendix D

Balancing dam stage/area, volume curves

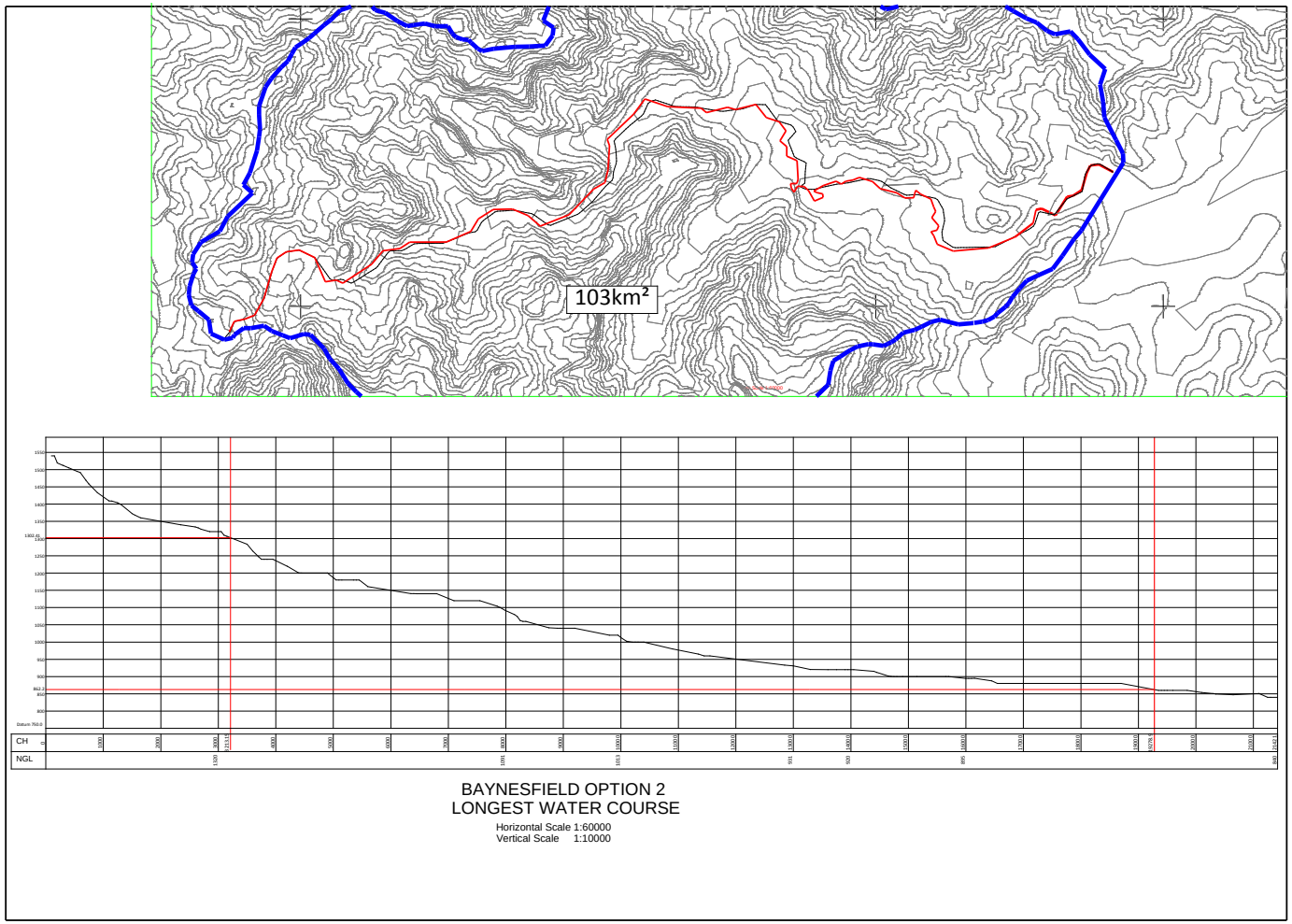

New Baynesfield Dam, Option 1- Storage Volume & Surface Area Curves
Surface Area (km²)
Elevation (m)
Storage Volume
Surface Area
Storage Volume (10⁶m³)


New Mabngweni Dam, Option 1 -Storage Volume & Surface Area Curves
Surface Area (km²)
Elevation (m)
Storage Volume
Surface Area
Storage Volume (10⁶m³)


New Baynesfield Dam, Option 2 - Storage Volume & Surface Area Curves
Surface Area (km²)
Elevation (m)
Storage Volume
Surface Area
Storage Volume (10⁶m³)

Appendix E

Catchment and longest watercourse, Option 2 New Baynesfield dam



BAYNESFIELD OPTION 2
LONGEST WATER COURSE

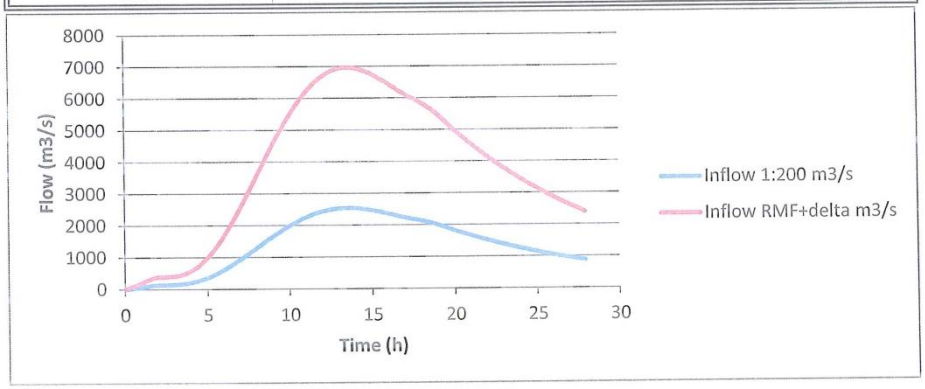
Horizontal Scale 1:60000
Vertical Scale 1:10000

Appendix F

Smithfield dam site, flood attenuation

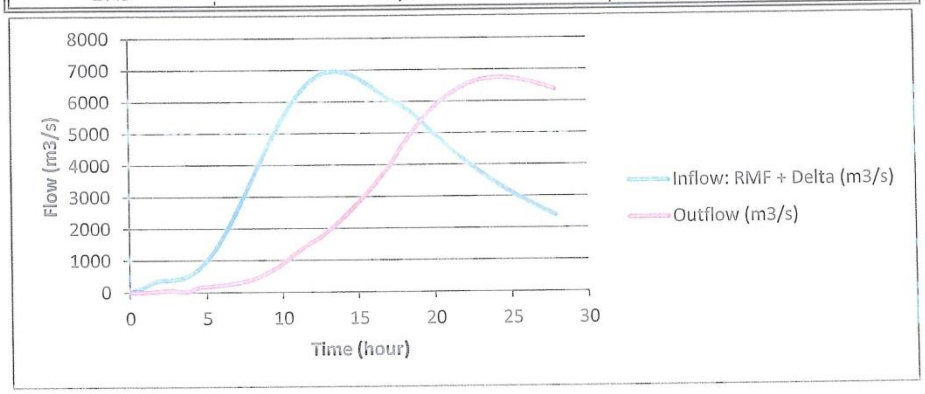
Smithfield Dam
Safety evalaution Hydrograph

Time (h)	Inflow 1:200 m3/s	Inflow RMF+delta m3/s
0	0	0
0.9	63.9	175
1.8	133.4	366
2.7	143.4	393
3.6	175.4	481
4.5	272.1	746
5.4	447.6	1,227
6.3	695.6	1,906
7.2	997.2	2,733
8.1	1326	3,634
9	1654	4,533
9.9	1954.3	5,356
10.8	2204.8	6,042
11.7	2389.9	6,550
12.6	2501.5	6,855
13.5	2540	6,961
14.4	2513.4	6,888
15.3	2437	6,679
16.2	2331.7	6,390
17.1	2222.1	6,090
18	2134.2	5,849
18.9	2014.1	5,520
19.8	1853.1	5,079
20.7	1704.9	4,672
21.6	1568.6	4,299
22.5	1443.2	3,955
23.4	1327.8	3,639
24.3	1221.6	3,348
25.2	1124	3,080
26.1	1034.1	2,834
27	951.4	2,607
27.9	875	2,398



uMkhumazi Feasibility Study
Flood Attenuation Results
Spillway ogee weir width 160m

Time (h)	Inflow: RMF + Delta (m^3/s)	Outflow (m^3/s)
0	0	0
0.9	175	7.5
1.8	366	30.2
2.7	393	66.8
3.6	481	11.5
4.5	746	152.6
5.4	1,227	194
6.3	1,906	239
7.2	2,733	300
8.1	3,634	417
9	4,533	610
9.9	5,356	854
10.8	6,042	1,196
11.7	6,550	1,495
12.6	6,855	1,753
13.5	6,961	2,108
14.4	6,888	2,506
15.3	6,679	2,957
16.2	6,390	3,446
17.1	6,090	3,983
18	5,849	4,655
18.9	5,520	5,229
19.8	5,079	5,717
20.7	4,672	6,099
21.6	4,299	6,382
22.5	3,955	6,587
23.4	3,639	6,702
24.3	3,348	6,737
25.2	3,080	6,709
26.1	2,834	6,628
27	2,607	6,511
27.9	2,398	6,369



Appendix G

New Baynesfield dam flood attenuation

BAYNESFIELD OPTION 2

FLOOD ROUTING - RDF

C factor determination

P/Ho=	0.5	Co=	2.097	(Design of small dams)			
Design inflow =(m³/s)		999		Design length(m) =	60	Design height (m) =	2.80
Design outflow=		588	RDF	FSL =	879.2		
Time of concentration (min) =		168					

Hydrograph

Time (min)	Time (s)	m³/s	Vol (m³)	Vol in	Area	Height	L (m)	C	$CLH^{1.5}$	Vol unit	Vol left	
0	0	0.00	0	51.0					0			
5	300	30	0.01	51.01	3.24	0.23	60	1.69	11	0.003	51.01	Inflow larger than outflow
10	600	59	0.02	51.02	3.24	0.23	60	1.69	11	0.003	51.02	Inflow larger than outflow
15	900	89	0.03	51.05	3.24	0.24	60	1.69	12	0.004	51.04	Inflow larger than outflow
20	1200	119	0.04	51.08	3.25	0.25	60	1.70	13	0.004	51.07	Inflow larger than outflow
25	1500	149	0.04	51.12	3.25	0.27	60	1.70	14	0.004	51.12	Inflow larger than outflow
30	1800	178	0.05	51.17	3.25	0.29	60	1.71	16	0.005	51.16	Inflow larger than outflow
35	2100	208	0.06	51.23	3.25	0.31	60	1.72	18	0.005	51.22	Inflow larger than outflow
40	2400	238	0.07	51.29	3.26	0.34	60	1.73	20	0.006	51.29	Inflow larger than outflow
45	2700	268	0.08	51.37	3.26	0.37	60	1.73	23	0.007	51.36	Inflow larger than outflow
50	3000	297	0.09	51.45	3.26	0.40	60	1.74	26	0.008	51.44	Inflow larger than outflow
55	3300	327	0.10	51.54	3.27	0.44	60	1.75	30	0.009	51.53	Inflow larger than outflow
60	3600	357	0.11	51.64	3.27	0.47	60	1.76	35	0.010	51.63	Inflow larger than outflow
65	3900	387	0.12	51.74	3.28	0.52	60	1.77	39	0.012	51.73	Inflow larger than outflow
70	4200	416	0.12	51.86	3.28	0.56	60	1.78	45	0.013	51.84	Inflow larger than outflow
75	4500	446	0.13	51.98	3.29	0.61	60	1.79	51	0.015	51.96	Inflow larger than outflow
80	4800	476	0.14	52.10	3.29	0.66	60	1.80	58	0.017	52.09	Inflow larger than outflow
85	5100	505	0.15	52.24	3.30	0.71	60	1.81	65	0.020	52.22	Inflow larger than outflow
90	5400	535	0.16	52.38	3.31	0.77	60	1.83	73	0.022	52.36	Inflow larger than outflow
95	5700	565	0.17	52.53	3.32	0.82	60	1.84	82	0.025	52.50	Inflow larger than outflow
100	6000	595	0.18	52.68	3.32	0.88	60	1.85	92	0.028	52.65	Inflow larger than outflow
105	6300	624	0.19	52.84	3.33	0.95	60	1.86	103	0.031	52.81	Inflow larger than outflow
110	6600	654	0.20	53.00	3.34	1.01	60	1.87	114	0.034	52.97	Inflow larger than outflow
115	6900	684	0.21	53.18	3.35	1.08	60	1.88	126	0.038	53.14	Inflow larger than outflow
120	7200	714	0.21	53.35	3.35	1.15	60	1.89	139	0.042	53.31	Inflow larger than outflow
125	7500	743	0.22	53.53	3.36	1.22	60	1.90	153	0.046	53.49	Inflow larger than outflow
130	7800	773	0.23	53.72	3.37	1.29	60	1.91	168	0.050	53.67	Inflow larger than outflow
135	8100	803	0.24	53.91	3.38	1.36	60	1.92	184	0.055	53.85	Inflow larger than outflow
140	8400	833	0.25	54.10	3.39	1.44	60	1.94	200	0.060	54.04	Inflow larger than outflow
145	8700	862	0.26	54.30	3.40	1.51	60	1.95	217	0.065	54.24	Inflow larger than outflow
150	9000	892	0.27	54.51	3.41	1.59	60	1.96	236	0.071	54.43	Inflow larger than outflow
155	9300	922	0.28	54.71	3.42	1.67	60	1.97	255	0.076	54.63	Inflow larger than outflow
160	9600	951	0.29	54.92	3.43	1.75	60	1.98	275	0.082	54.84	Inflow larger than outflow
165	9900	981	0.29	55.13	3.44	1.83	60	1.99	296	0.089	55.04	Inflow larger than outflow
170	10200	993	0.30	55.34	3.45	1.91	60	2.00	317	0.095	55.25	Inflow larger than outflow
175	10500	978	0.29	55.54	3.46	1.99	60	2.01	338	0.101	55.44	Inflow larger than outflow
180	10800	963	0.29	55.73	3.47	2.06	60	2.02	357	0.107	55.62	Inflow larger than outflow
185	11100	948	0.28	55.90	3.48	2.13	60	2.02	377	0.113	55.79	Inflow larger than outflow
190	11400	934	0.28	56.07	3.48	2.19	60	2.03	395	0.119	55.95	Inflow larger than outflow
195	11700	919	0.28	56.23	3.49	2.25	60	2.04	413	0.124	56.11	Inflow larger than outflow
200	12000	904	0.27	56.38	3.50	2.31	60	2.04	429	0.129	56.25	Inflow larger than outflow
205	12300	889	0.27	56.51	3.50	2.36	60	2.05	445	0.134	56.38	Inflow larger than outflow
210	12600	874	0.26	56.64	3.51	2.41	60	2.06	460	0.138	56.50	Inflow larger than outflow
215	12900	859	0.26	56.76	3.52	2.45	60	2.06	475	0.142	56.62	Inflow larger than outflow
220	13200	844	0.25	56.87	3.52	2.49	60	2.07	488	0.146	56.73	Inflow larger than outflow
225	13500	830	0.25	56.98	3.53	2.53	60	2.07	500	0.150	56.83	Inflow larger than outflow
230	13800	815	0.24	57.07	3.53	2.57	60	2.07	512	0.154	56.92	Inflow larger than outflow
235	14100	800	0.24	57.16	3.53	2.60	60	2.08	522	0.157	57.00	Inflow larger than outflow
240	14400	785	0.24	57.24	3.54	2.63	60	2.08	532	0.160	57.08	Inflow larger than outflow
245	14700	770	0.23	57.31	3.54	2.66	60	2.08	541	0.162	57.14	Inflow larger than outflow
250	15000	755	0.23	57.37	3.54	2.68	60	2.09	549	0.165	57.21	Inflow larger than outflow
255	15300	740	0.22	57.43	3.55	2.70	60	2.09	556	0.167	57.26	Inflow larger than outflow
260	15600	725	0.22	57.48	3.55	2.72	60	2.09	563	0.169	57.31	Inflow larger than outflow
265	15900	711	0.21	57.52	3.55	2.74	60	2.09	568	0.171	57.35	Inflow larger than outflow
270	16200	696	0.21	57.56	3.55	2.75	60	2.09	573	0.172	57.39	Inflow larger than outflow
275	16500	681	0.20	57.59	3.55	2.76	60	2.09	577	0.173	57.42	Inflow larger than outflow
280	16800	666	0.20	57.62	3.56	2.77	60	2.09	581	0.174	57.45	Inflow larger than outflow
285	17100	651	0.20	57.64	3.56	2.78	60	2.10	584	0.175	57.47	Inflow larger than outflow
290	17400	636	0.19	57.66	3.56	2.79	60	2.10	586	0.176	57.48	Inflow larger than outflow
295	17700	621	0.19	57.67	3.56	2.79	60	2.10	587	0.176	57.49	Inflow larger than outflow
300	18000	607	0.18	57.67	3.56	2.79	60	2.10	588	0.176	57.50	Inflow larger than outflow
305	18300	592	0.18	57.68	3.56	2.79	60	2.10	588	0.176	57.50	Inflow larger than outflow
310	18600	577	0.17	57.67	3.56	2.79	60	2.10	587	0.176	57.50	Outflow larger than inflow
315	18900	562	0.17	57.66	3.56	2.79	60	2.10	586	0.176	57.49	Outflow larger than inflow
320	19200	547	0.16	57.65	3.56	2.79	60	2.10	585	0.175	57.48	Outflow larger than inflow

BAYNESFIELD OPTION 2

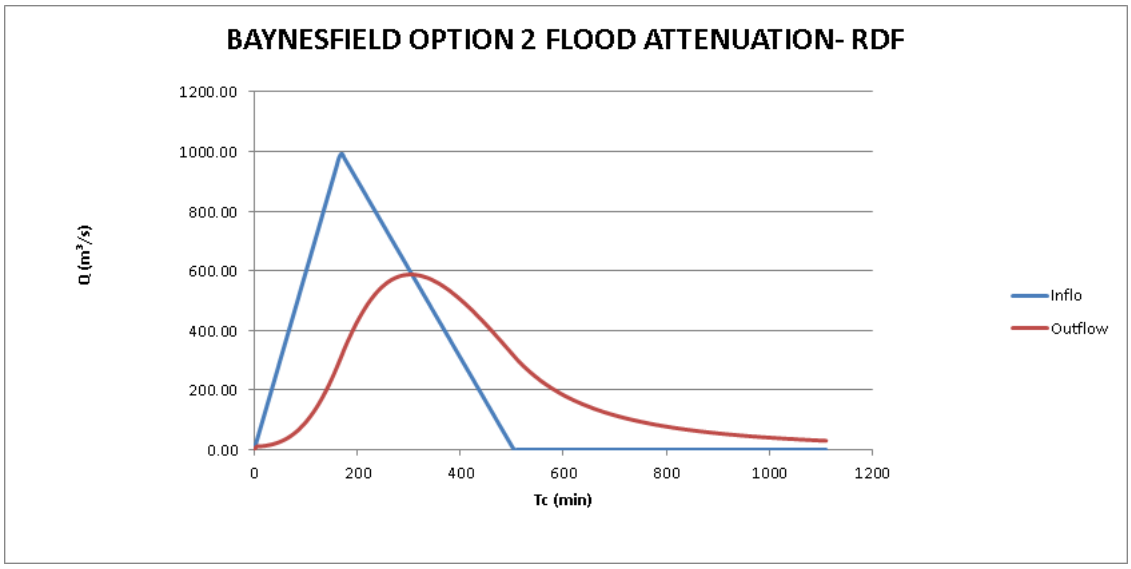
FLOOD ROUTING - SEF

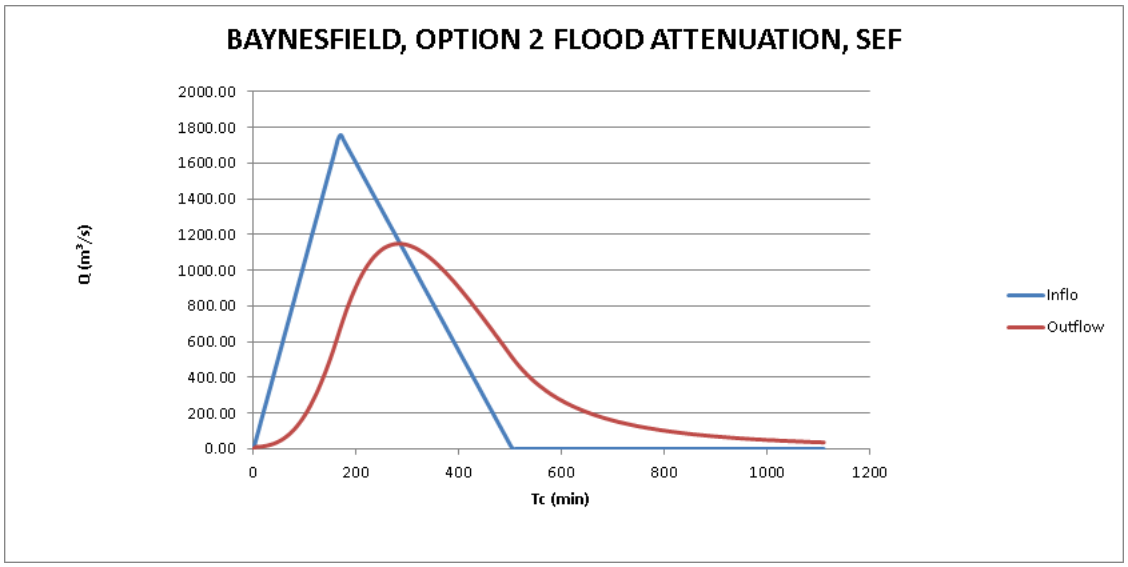
C factor determination

P/Ho=	0.5	Co=	2.097	(Design of small dams)			
Design inflow =(m³/s)		1769		Design length(m) =	60	Design height (m) =	2.80
			RDF	FSL =	879.2		
Time of concentration (min) =			168				

Hydrograph

Time (min)	Time (s)	m³/s	Vol (m³)	Vol in	Area	Height	L (m)	C	$CLH^{1.5}$	Vol unit	Vol left	
0	0	0.00	0	51.0					0			
5	300	53	0.02	51.02	3.24	0.23	60	1.69	11	0.003	51.01	Inflow larger than outflow
10	600	105	0.03	51.04	3.24	0.24	60	1.69	12	0.004	51.04	Inflow larger than outflow
15	900	158	0.05	51.09	3.25	0.26	60	1.70	13	0.004	51.08	Inflow larger than outflow
20	1200	211	0.06	51.15	3.25	0.28	60	1.71	15	0.005	51.14	Inflow larger than outflow
25	1500	263	0.08	51.22	3.25	0.31	60	1.72	18	0.005	51.22	Inflow larger than outflow
30	1800	316	0.09	51.31	3.26	0.35	60	1.73	21	0.006	51.30	Inflow larger than outflow
35	2100	369	0.11	51.42	3.26	0.39	60	1.74	25	0.008	51.41	Inflow larger than outflow
40	2400	421	0.13	51.53	3.27	0.43	60	1.75	30	0.009	51.52	Inflow larger than outflow
45	2700	474	0.14	51.67	3.27	0.49	60	1.76	36	0.011	51.66	Inflow larger than outflow
50	3000	526	0.16	51.81	3.28	0.54	60	1.78	43	0.013	51.80	Inflow larger than outflow
55	3300	579	0.17	51.98	3.29	0.61	60	1.79	51	0.015	51.96	Inflow larger than outflow
60	3600	632	0.19	52.15	3.30	0.68	60	1.81	60	0.018	52.13	Inflow larger than outflow
65	3900	684	0.21	52.34	3.31	0.75	60	1.82	71	0.021	52.32	Inflow larger than outflow
70	4200	737	0.22	52.54	3.32	0.83	60	1.84	83	0.025	52.51	Inflow larger than outflow
75	4500	790	0.24	52.75	3.33	0.91	60	1.85	97	0.029	52.72	Inflow larger than outflow
80	4800	842	0.25	52.97	3.34	1.00	60	1.87	112	0.033	52.94	Inflow larger than outflow
85	5100	895	0.27	53.21	3.35	1.09	60	1.88	128	0.039	53.17	Inflow larger than outflow
90	5400	948	0.28	53.45	3.36	1.18	60	1.90	147	0.044	53.41	Inflow larger than outflow
95	5700	1000	0.30	53.71	3.37	1.28	60	1.91	167	0.050	53.66	Inflow larger than outflow
100	6000	1053	0.32	53.97	3.38	1.39	60	1.93	189	0.057	53.92	Inflow larger than outflow
105	6300	1106	0.33	54.25	3.40	1.49	60	1.94	213	0.064	54.19	Inflow larger than outflow
110	6600	1158	0.35	54.53	3.41	1.60	60	1.96	238	0.072	54.46	Inflow larger than outflow
115	6900	1211	0.36	54.83	3.42	1.71	60	1.97	266	0.080	54.75	Inflow larger than outflow
120	7200	1264	0.38	55.12	3.44	1.83	60	1.99	295	0.089	55.04	Inflow larger than outflow
125	7500	1316	0.39	55.43	3.45	1.95	60	2.00	326	0.098	55.33	Inflow larger than outflow
130	7800	1369	0.41	55.74	3.47	2.07	60	2.02	359	0.108	55.64	Inflow larger than outflow
135	8100	1422	0.43	56.06	3.48	2.19	60	2.03	394	0.118	55.94	Inflow larger than outflow
140	8400	1474	0.44	56.39	3.50	2.31	60	2.05	431	0.129	56.26	Inflow larger than outflow
145	8700	1527	0.46	56.72	3.51	2.43	60	2.06	469	0.141	56.57	Inflow larger than outflow
150	9000	1579	0.47	57.05	3.53	2.56	60	2.07	509	0.153	56.90	Inflow larger than outflow
155	9300	1632	0.49	57.39	3.54	2.69	60	2.09	551	0.165	57.22	Inflow larger than outflow
160	9600	1685	0.51	57.73	3.56	2.81	60	2.10	594	0.178	57.55	Inflow larger than outflow
165	9900	1737	0.52	58.07	3.58	2.94	60	2.11	639	0.192	57.88	Inflow larger than outflow
170	10200	1758	0.53	58.40	3.59	3.07	60	2.12	685	0.205	58.20	Inflow larger than outflow
175	10500	1732	0.52	58.72	3.61	3.18	60	2.14	728	0.218	58.50	Inflow larger than outflow
180	10800	1706	0.51	59.01	3.62	3.29	60	2.15	769	0.231	58.78	Inflow larger than outflow
185	11100	1679	0.50	59.28	3.63	3.39	60	2.16	808	0.242	59.04	Inflow larger than outflow
190	11400	1653	0.50	59.54	3.64	3.49	60	2.16	845	0.254	59.28	Inflow larger than outflow
195	11700	1627	0.49	59.77	3.65	3.57	60	2.17	880	0.264	59.51	Inflow larger than outflow
200	12000	1601	0.48	59.99	3.66	3.65	60	2.18	913	0.274	59.72	Inflow larger than outflow
205	12300	1574	0.47	60.19	3.67	3.73	60	2.19	943	0.283	59.90	Inflow larger than outflow
210	12600	1548	0.46	60.37	3.68	3.79	60	2.19	971	0.291	60.08	Inflow larger than outflow
215	12900	1522	0.46	60.53	3.69	3.85	60	2.20	996	0.299	60.24	Inflow larger than outflow
220	13200	1495	0.45	60.68	3.70	3.91	60	2.20	1020	0.306	60.38	Inflow larger than outflow
225	13500	1469	0.44	60.82	3.70	3.96	60	2.21	1041	0.312	60.51	Inflow larger than outflow
230	13800	1443	0.43	60.94	3.71	4.00	60	2.21	1060	0.318	60.62	Inflow larger than outflow
235	14100	1416	0.42	61.05	3.71	4.04	60	2.21	1077	0.323	60.72	Inflow larger than outflow
240	14400	1390	0.42	61.14	3.72	4.07	60	2.22	1092	0.328	60.81	Inflow larger than outflow
245	14700	1364	0.41	61.22	3.72	4.10	60	2.22	1106	0.332	60.89	Inflow larger than outflow
250	15000	1337	0.40	61.29	3.72	4.13	60	2.22	1117	0.335	60.96	Inflow larger than outflow
255	15300	1311	0.39	61.35	3.72	4.15	60	2.22	1126	0.338	61.01	Inflow larger than outflow
260	15600	1285	0.39	61.40	3.73	4.17	60	2.22	1134	0.340	61.06	Inflow larger than outflow
265	15900	1258	0.38	61.43	3.73	4.18	60	2.22	1140	0.342	61.09	Inflow larger than outflow
270	16200	1232	0.37	61.46	3.73	4.19	60	2.22	1145	0.343	61.12	Inflow larger than outflow
275	16500	1206	0.36	61.48	3.73	4.20	60	2.23	1148	0.344	61.14	Inflow larger than outflow
280	16800	1179	0.35	61.49	3.73	4.20	60	2.23	1149	0.345	61.14	Inflow larger than outflow
285	17100	1153	0.35	61.49	3.73	4.20	60	2.23	1149	0.345	61.15	Inflow larger than outflow
290	17400	1127	0.34	61.48	3.73	4.20	60	2.23	1148	0.344	61.14	Outflow larger than inflow
295	17700	1100	0.33	61.47	3.73	4.19	60	2.23	1146	0.344	61.13	Outflow larger than inflow
300	18000	1074	0.32	61.45	3.73	4.18	60	2.22	1142	0.343	61.10	Outflow larger than inflow
305	18300	1048	0.31	61.42	3.73	4.17	60	2.22	1138	0.341	61.08	Outflow larger than inflow


BAYNESFIELD OPTION 2 FLOOD ATTENUATION- RDF
Q (m³/s)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
0
200
400
600
800
1000
1200
Tc (min)
Inflo
Outflow


BAYNESFIELD, OPTION 2 FLOOD ATTENUATION, SEF
Q (m³/s)
2000.00
1800.00
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
0
200
400
600
800
1000
1200
Tc (min)
Inflo
Outflow

Appendix H

Smithfield dam site A, Option 1

BOQ

SITE A, OPTION 1
with
OUTLET WORKS TO PUMPSTATION

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		PART 2: RIVER DIVERSION				
		STAGE 1				
1	**SANS 1200 C**	**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.2	26 546.00	31 855
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700.00	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	1800	20.00	36 000
2	**P10**	**EXCAVATION AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	122 615	21.00	2 574 915
		(b) Extra over for:				
		(i) Intermediate	m³	30 654	3.30	101 157
		(ii) Hard Rock	m³	30 654	34.00	1 042 228
		(iii) Boulder, Class A	m³	12 262	78.00	956 397
		(iv) Boulder, Class B	m³	6 131	61.00	373 976
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	86 651	21.00	1 819 671
		(b) Extra over for:				
		(i) Intermediate	m³	21 663	3.30	71 487
		(ii) Hard Rock	m³	21 663	34.00	736 534
		(iii) Boulder, Class A	m³	12 998	78.00	1 013 817
		(iv) Boulder, Class B	m³	4 333	61.00	264 286
	2.3	Dewatering	Sum	1	100 000.00	100 000
		STAGE 2				
3	**SANS 1200 C**	**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	1.3	26 546.00	34 510
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700.00	3 400
4	**P10**	**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	4.1	(a) Excavate all materials				
		(i) Excavate and dispose footprint of Upstream & Downstream cofferdam	m³	4 757	21.00	99 897
TOTAL CARRIED FORWARD						**9 263 528**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**9 263 528**
5	**P21**	**EMBANKMENT CONSTRUCTION**				
		Earthfill Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
		Using material from designated borrow areas or commercial sources				
	5.1	(4) Homogeneous Material	m³	65853	50	3 292 650
6		**TUNNEL CONSTRUCTION**				
	6.1	**TUNNEL EXCAVATION**				
		(a) Tunnel (Rock class II)	m³	40186	2 051	82 402 471
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	17040	37	623 886
		(b) Shotcrete	m³	814	2 500	2 035 929
		(c) Reinforcing mesh	m²	5297	26	137 715
	6.3	Dewatering	Sum	1	550 000	550 000
		STAGE 3				
7		**MEDIUM PRESSURE PIPELINES**				
	7.1	Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	299	80	23 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
8		**PLUG OF TUNNEL**				
	8.1	Scheduled Formwork items				
		Class F1 (a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
	8.3	Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19 mm	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.4	Joints				
	8.5	(e) Swellable water stops	m	30	500	15 000
	8.6	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**101 268 848**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9	**SANS 1200 C**	**SITE CLEARANCE**				
	9.1	Clear and grub				
		(a) Embankment footprint	ha	13.40	26 546	355 716
		(b) Spillway	ha	19.70	13 635	268 610
	9.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint	No	5	1 700	8 500
		(ii) Spillway	No	2	1 700	3 400
	9.3	Remove topsoil to nominal depth of 300 mm and stockpile				
		(a) Embankment footprint	m³	40 332	21	846 972
		(b) Spillway	m³	59 643	16	954 288
10	**P10**	**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	10.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35	0
		(2) Spillway (Use in Rockfill)	m³	0	31	0
		(3) Portals (Use in Rockfill)	m³	0	35	0
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3	0
		(ii) Hard rock excavation	m³	0	34	0
		(iii) Boulder excavation, Class A	m³	0	79	0
		(iv) Boulder excavation, Class B	m³	0	61	0
	10.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	7 326	664	4 864 464
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	7 326	660	4 835 160
TOTAL CARRIED FORWARD						**12 137 110**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
11	**P21**	**EMBANKMENT CONSTRUCTION**				
	11.1	Forming Embankment				
		Using material from designated borrow areas				
		(1) Rockfill	m³	2 826 165	71	200 657 715
		(2) Clay Core	m³	584 300	50	29 215 000
		(3) Filter	m³	172 215	450	77 496 750
	11.2	Overhaul (Clay for 10 km)	m³.km	141 308	3	423 925
12		**SECTION : DRILLING & GROUTING**				
		(a) Curtain grouting	m	850	13 457	11 438 450
		(b) Consolidation grouting	m	850	2 820	2 397 000
TOTAL CARRIED FORWARD TO SUMMARY						**321 628 840**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
13	**P20**	**CONVENTIONAL CONCRETE FOR DAMS**				
	13.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	2 412	550	1 326 600
		(2) Transfer structructure	m²	8 859	550	4 872 450
		(b) Sloped				
		(1) Ogee of spillway - Drawing (05/02)	m²	1 364	550	750 200
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	550	18 150
		(e) Horizontal	m²	64	550	35 200
		Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	13.2	Scheduled Reinforcement items	t	4 408	8 400	37 023 840
	13.3	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	77	8 500	654 883
	13.4	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	31 338	1 500	47 007 000
		(2) Tranfer intake	m³	36 251	1 500	54 376 500
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	100	1 800	180 000
	13.5	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m^2	333	23	7 659
		(b) Top of bridges	m^2	197	23	4 531
		(c) Chute and Stilling basin floor	m²	24 420	23	561 660
		(d) Transfer intake	m²	714	25.00	17 840
14		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
		(d) Pipe (2 x 2diam steel pipe)	m	600	20 000	12 000 000
		(e) Pipes from pumpstation to tunnel inlet	m	600	18 000	10 800 000
TOTAL CARRIED FORWARD						**180 521 484**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**180 521 484**
15		**WATERSTOPS, JOINTING AND BEARINGS**				
		Scheduled items				
	15.1	Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	1 280	630	806 526
	15.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	1 280	10	12 802
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	1 280	10	12 802
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	1 280	10	12 802
16		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	16.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	305	21	6 410
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	153	4	611
	16.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	293	550	161 172
	16.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	1 221	400	488 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	370	330	122 100
	16.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	19	50	925
	16.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
	16.6	Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	2 930	3	8 791
17		**ROAD DEVIATION TO ACCOMMODATE DAM LEVEL**				
		(a) Road (1 300 m long x 11,4 m wide)	m²	14 820	770	11 411 400
		(b) Bridges (230 m long bridges x 11.4 m wide)	m²	2 622	15 000	39 330 000
TOTAL CARRIED FORWARD TO SUMMARY						**232 901 025**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
18		**SITE CLEARANCE**				
	18.1	Clear and grub				
		(a) Footprint	ha	0.05	26 546	1 327
	18.2	Remove and grub large trees and tree				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint	No	1	1 700	1 700
	18.3	Remove topsoil to nominal depth of 300				
		(a) Footprint	m³	150	21	3 150
19		**EXCAVATIONS AND BACKFILL FOR**				
	19.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	3570	35	124 950
		(b) Extra over for:				
		(i) Intermediate excavation	m³	1 071	3	3 427
		(ii) Hard rock excavation	m³	714	34	24 276
		(iii) Boulder excavation, Class A	m³	179	79	14 012
		(iv) Boulder excavation, Class B	m³	179	61	10 889
	19.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	510	664	338 640
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	510	660	336 600

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL CARRIED FORWARD						**858 971**
20		Scheduled Reinforcement items Steel				
		(a) High tensile steel 16 mm diameter and over	t	169	8 400	1 417 080
21		Scheduled Concrete items				
		Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m^3	474	1 869	886 467
		Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m^3	1 687	1 500	2 530 500
		Secondary concrete (Class 30/19)	m^3	100	1 870	187 000
22		Unformed Surface Finishes				
		Class U2 finish	m^2	2 489	29	72 181
TOTAL CARRIED FORWARD TO SUMMARY						**5 093 228**

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
23		**Landscaping** (% of 1-9)	%	673 029 051	5	33 651 453
24		**Miscellaneous** (% of 1-9)	%	673 029 051	15	101 627 387
		SUB TOTAL A				808 307 890
25		**Preliminary & General** (% of sub-total A)	%	808 307 890	30	242 492 367
26		**Preliminary works**				
	26.1	(a) Access road	km	4.6	400 000	1 840 000
	26.2	(b) Electrical supply to site	Sum			1 000 000
	26.3	(c) Construction water to site	Sum			300 000
	26.4	(d) Railhead & materials handling	Sum			
	23.5	Accommodation	Sum			300 000
		SUB TOTAL B				1 054 240 257
27		**Contingencies** (% of sub total B)	%	1 054 240 257	10	105 424 026
		SUB TOTAL C				1 159 664 283
28		**Planning design & supervision** (% of sub total C)	%	1 159 664 283	15	173 949 642
		SUB TOTAL D				1 333 613 926
29		**VAT** (% of sub total D)	%	1 333 613 926	0	0
		NETT PROJECT COST				1 333 613 926
30		**Cost of relocations**	Sum			
31		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 333 613 926

SITE A, OPTION 1
with
OUTLET WORKS TO TUNNEL INLET

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
15		**Landscaping** (% of 1-9)	%	670 935 823	5	33 546 791
16		**Miscellaneous** (% of 1-9)	%	670 935 823	15	100 640 374
		SUB TOTAL A				805 122 988
17		**Preliminary & General** (% of sub-total A)	%	805 122 988	30	241 536 896
18		**Preliminary works**				
	18.1	(a) Access road	km	4.6	400 000	1 840 000
	18.2	(b) Electrical supply to site	Sum			1 000 000
	18.3	(c) Construction water to site	Sum			300 000
	18.4	(d) Railhead & materials handling	Sum			
	18.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				1 050 099 885
19		**Contingencies** (% of sub total B)	%	1 050 099 885	10	105 009 988
		SUB TOTAL C				1 155 109 873
20		**Planning design & supervision** (% of sub total C)	%	1 155 109 873	15	173 266 481
		SUB TOTAL D				1 328 376 354
21		**VAT** (% of sub total D)	%	1 328 376 354	0	0
		NETT PROJECT COST				1 328 376 354
22		**Cost of relocations**	Sum			
23		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 328 376 354

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
		Clear and grub				
		(a) Portal footprints	ha	1.2	26 546.00	31 855
		Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700.00	3 400
		Remove topsoil to nominal depth of 150 mm and stockpile	m³	1800	20.00	36 000
2		**EXCAVATION AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	122 615	21.00	2 574 915
		(b) Extra over for:				
		(i) Intermediate	m³	30 654	3.30	101 157
		(ii) Hard Rock	m³	30 654	34.00	1 042 228
		(iii) Boulder, Class A	m³	12 262	78.00	956 397
		(iv) Boulder, Class B	m³	6 131	61.00	373 976
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	86 651	21.00	1 819 671
		(b) Extra over for:				
		(i) Intermediate	m³	21 663	3.30	71 487
		(ii) Hard Rock	m³	21 663	34.00	736 534
		(iii) Boulder, Class A	m³	12 998	78.00	1 013 817
		(iv) Boulder, Class B	m³	4 333	61.00	264 286
3		**EMBANKMENT CONSTRUCTION**				
		Dewatering	Sum	1	100 000.00	100 000
		STAGE 2				
4		**SITE CLEARANCE**				
	4.1	Clear and grub				
		(a) Embankment footprint	ha	1.3	26 546.00	34 510
		Remove and grub large trees and tree stumps of girth				
	4.2	(a) over 1 m and up to and including 2 m	No	2	1 700.00	3 400
5		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
		(a) Excavate all materials				
		(i) Excavate and dispose footprint of Upstream & Downstream cofferdam	m³	4 757	21.00	99 897
TOTAL CARRIED FORWARD						**9 263 528**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**9 263 528**
		EMBANKMENT CONSTRUCTION				
		Earthfille Upstream & Downstream Cofferdam Construction.				
6		Forming Embankment				
		Using material from designated borrow areas or commercial sources				
		(4) Homogeneous Material	m³	65853	50	3 292 650
7		**TUNNEL CONSTRUCTION**				
	7.1	**Tunnel excavation**				
		(a) Tunnel (Rock class II)	m³	40186	2 051	82 402 471
	7.2	**Rock support**				
		(a) Rockbolts	m	17040	37	623 886
		(b) Shotcrete	m³	814	2 500	2 035 929
		(c) Reinforcing mesh	m²	5297	26	137 715
	7.3	Dewatering	Sum	1	550 000	550 000
		STAGE 3				
8		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	299	80	23 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
9		**Plug of Tunnel (Stage 3)**				
	9.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	9.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19 mm	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	9.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	9.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**101 268 848**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
6		**SITE CLEARANCE**				
	6.1	Clear and grub				
		(a) Embankment footprint	ha	13.40	26 546	355 716
		(b) Spillway	ha	19.70	13 635	268 610
	6.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint	No	5	1 700	8 500
		(ii) Spillway	No	2	1 700	3 400
	6.3	Remove topsoil to nominal depth of 300 mm and stockpile				
		(a) Embankment footprint	m³	40 332	21	846 972
		(b) Spillway	m³	59 643	16	954 288
7		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	7.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35	0
		(2) Spillway (Use in Rockfill)	m³	0	31	0
		(3) Portals (Use in Rockfill)	m³	0	35	0
	7.2	(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3	0
		(ii) Hard rock excavation	m³	0	34	0
		(iii) Boulder excavation, Class A	m³	0	79	0
		(iv) Boulder excavation, Class B	m³	0	61	0
	7.3	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	7 326	664	4 864 464
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	7 326	660	4 835 160
TOTAL CARRIED FORWARD						**12 137 110**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
8		**EMBANKMENT CONSTRUCTION**				
	8.1	Forming Embankment				
		Using material from designated borrow areas				
		(1) Rockfill	m³	2 826 165	71	200 657 715
		(2) Clay Core	m³	584 300	50	29 215 000
		(3) Filter	m³	172 215	450	77 496 750
		Overhaul (Clay for 10 km)	m³.km	141 308	3	423 925
9		**SECTION : DRILLING & GROUTING**				
		(a) Curtain grouting	m	850	13 457	11 438 450
		(b) Consolidation grouting	m	850	2 820	2 397 000
TOTAL CARRIED FORWARD TO SUMMARY						**321 628 840**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
10		**CONVENTIONAL CONCRETE FOR DAMS**				
	10.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	2 412	550	1 326 600
		(2) Transfer structructure	m²	8 859	550	4 872 450
		(b) Sloped				
		(1) Ogee of spillway - Drawing (05/02)	m²	1 364	550	750 200
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	550	18 150
		(e) Horizontal	m²	64	550	35 200
		Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	10.2	Scheduled Reinforcement items	t	4 408	8 400	37 023 840
	10.3	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	77	8 500	654 883
	10.4	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	31 338	1 500	47 007 000
		(2) Tranfer intake	m³	36 251	1 500	54 376 500
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	100	1 800	180 000
	10.5	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m²	333	23	7 659
		(b) Top of bridges	m²	197	23	4 531
		(c) Chute and Stilling basin floor	m²	24 420	23	561 660
		(d) Transfer intake	m²	714	25	17 840
11		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
		(d) Pipe (2 x 2diam steel pipe)	m	1 290	20 000	25 800 000
TOTAL CARRIED FORWARD						**183 521 484**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**183 521 484.35**
12		**WATERSTOPS, JOINTING AND BEARINGS**				
		Scheduled items				
		Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	1 280	630	806 526
		Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	1 280	10	12 802
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	1 280	10	12 802
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	1 280	10	12 802
13		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	13.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	305	21	6 410
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	153	4	611
	13.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	293	550	161 172
	13.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	1 221	400	488 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	370	330	122 100
	13.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	19	50	925
	13.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
		Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	2 930	3	8 791
14		**ROAD DEVIATION TO ACCOMMODATE DAM LEVEL**				
		(a) Road (1 300 m long x 11,4 m wide)	m²	14 820	770	11 411 400
		(b) Bridges (230 m long bridges x 11.4 m wide)	m²	2 622	15 000	39 330 000
TOTAL CARRIED FORWARD TO SUMMARY						**235 901 025**

Appendix I

Smithfield Dam site A, Option 2

BOQ

SITE A, OPTION 2
WITH
OUTLET TO PUMPSTATION

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
19	1-12	**Landscaping** (% of 1-9)	%	938 152 519	5	46 907 626
20	1-12	**Miscellaneous** (% of 1-9)	%	938 152 519	15	140 722 878
		SUB TOTAL A				1 125 783 023
21		**Preliminary & General** (% of sub-total A)	%	1 125 783 023	30	337 734 907
22		**Preliminary works**				
	22.1	(a) Access road	km	5	400 000	1 840 000.00
	22.2	(b) Electrical supply to site	Sum			1 000 000
	22.3	(c) Construction water to site	Sum			300 000
	22.4	(d) Railhead & materials handling	Sum			
	22.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				1 466 957 929
23		**Contingencies** (% of sub total B)	%	1 466 957 929	10	146 695 793
		SUB TOTAL C				1 613 653 722
24		**Planning design & supervision** (% of sub total C)	%	1 613 653 722	15	242 048 058
		SUB TOTAL D				1 855 701 781
25		**VAT** (% of sub total D)	%	1 855 701 781	0	0
		NETT PROJECT COST				1 855 701 781
26		**Cost of relocations**	Sum			
27		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 855 701 781

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
1	1	**SITE CLEARANCE**				
	1.2	Clear and grub				
		(a) Right flank footprint	ha	12.60	26 600	335 160
		(b) RCC footprint	ha	1.80	26 601	47 882
	1.3	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Whole footprint area	No	5	1 700	8 500
	1.4	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Right flank embankent	m³	38 113	21	800 373
		(b) RCC	m³	5 481	21	115 101
2	2.0	**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	2.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Right flank core	m³	19071	30	572 130
		(2) RCC excavation	m³	98485	30	2 954 550
		(b) Extra over for:				
		(i) Intermediate excavation	m³	35 267	4	141 067
		(ii) Hard rock excavation	m³	23 511	34	799 381
		(iii) Boulder excavation, Class A	m³	5 878	79	464 346
		(iv) Boulder excavation, Class B	m³	954	61	58 167
	2.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	5 400	665	3 591 000
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	5 400	658	3 553 200
TOTAL CARRIED FORWARD						**13 440 857**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3		**PART 2 : RIVER DIVERSION**	**Sum**	**1**		**15 000 000**
4		**EMBANKMENT**				
		SECTION: EARTHFILL DAM CONSTRUCTION				
		Embankment				
	4.1	(a) Trial Embankment	No			146 619
	4.2	(b) Forming right flank embankment				
		(1) Earth fill	m³	1824788	46	83 940 248
		(2) Filters	m³	80232	431	34 579 992
		(3) Riprap	m³	374	351	131 274
		(4) Clay core	m³	446072	50	22 303 600
5		**CONCRETE STRUCTURE**				
		SECTION: CONVENTIONAL CONCRETE FOR DAMS				
		SCHEDULED FORMWORK ITEMS				
		Class F2				
	5.1	(a) Vertical				
		(1) Wall (downstream and upstream)	m^2	44 456	610	27 118 160
		(2) Outletworks	m²	6 210	610	3 788 100
	5.2	(c) Forming of Gallery				
		(1) Horizontal	m	411	6 500	2 671 500
		(2) Sloping	m	200	8 000	1 600 000
6		SCHEDULED REINFORCEMENT ITEMS	t	1 321	8 400	11 097 240
7		SCHEDULED CONCRETE ITEMS				
	7.1	Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Apron (160m x 1m x 23m)	m³	3 680	1 768	6 506 240
		(2) Outlet works	m³	9 531	1 768	16 850 808
		(3) River diversion slot	m³	30 654	1 768	54 196 272
	7.2	UNFORMED SURFACE FINISH				
8	8.1	Class U2 (Wood-floated) finish				
		(a) Concrete wall structure	m^2	17 496	50	874 800
		(b) Apron (downstream)	m^2	3 680	50	184 000
		(c) Gallery floor	m^2	411	50	20 550
		(d) Outlet works	m²	324	50	16 200
9		**ROAD DEVIATION TO ACCOMMODATE DAM LEVEL**				
		(a) Road (1 300 m long x 11,4 m wide)	m²	14 820	770	11 411 400
		(b) Bridges (230 m long bridges x 11.4 m wide)	m²	2 622	15 000	39 330 000
TOTAL CARRIED FORWARD						**331 767 003**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						**331 767 003**
10		**SECTION: ROLLER COMPACTED CONCRETE FOR DAMS**				
	10.1	Roller Compacted Concrete				
		(a) Grade 15 MPa concrete				
		(1) Wall	m^3	477 498	950	453 623 323
		(2) Additional for two separate wall sections	m^3	477 498	100	47 749 823
	10.2	(b) Immersion Vibrated Roller Compacted Concrete (IVRCC)				
		(1) 600 mm thick, upstream	m^3	13 337	1 100	14 670 401
		(2) 600 mm thick, downstream	m^2	16 410	1 100	18 051 040
	10.3	RCC Bedding Mortar				
		(a) Grade 15 MPa concrete	m^2	17 496	500	8 748 000
	9.4	Test Section	No.	1	840 000	840 000
11		**SECTION : DRILLING & GROUTING**				
	11.1	**RCC WALL**				
		(a) Curtain grouting	m	18 504	850	15 728 400
		(b) Consolidation grouting	m	4 006	850	3 405 100
	11.2	**EARTH EMABANKMENT**				
		(a) Curtain grouting	m	10 352	850	8 799 200
		(b) Consolidation grouting	m	1 714	850	1 456 900
12		**SECTION: WATERSTOPS, JOINTING AND BEARINGS**				
		SCHEDULED ITEMS				
	12.1	Waterstops	m	1 482	700	1 037 301
13		**SECTION: MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes and hoists	Sum			2 330 000
		(c) Structural steel screens and guides	Sum			1 712 971
		(d) Pipe (2 x 2m steel pipe)	m	100	20 000	2 000 000
TOTAL CARRIED FORWARD						**918 759 463**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		**SITE CLEARANCE**				
	14.1	Clear and grub				
		(a) Footprint	ha	0.05	26 546	1 327
	14.2	Remove and grub large trees and tree				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint	No	1	1 700	1 700
	14.3	Remove topsoil to nominal depth of 300 mm				
		(a) Footprint	m^3	150	21	3 150
15		**EXCAVATIONS AND BACKFILL FOR**				
	15.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m^3	3570	35	124 950
		(b) Extra over for:				
		(i) Intermediate excavation	m^3	1 071	3	3 427
		(ii) Hard rock excavation	m^3	714	34	24 276
		(iii) Boulder excavation, Class A	m^3	179	79	14 012
		(iv) Boulder excavation, Class B	m^3	179	61	10 889
	15.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and	m^3	510	664	338 640
		(b) Treatment of Faults, Dykes, Shear	m^3	510	660	336 600
16		Scheduled Reinforcement items				
		Steel				
		(a) High tensile steel 16 mm diameter and	t	169	8 400	1 417 080
17		Scheduled Concrete items				
		Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m^3	474	1 869	886 467
		Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m^3	1 687	1 500	2 530 500
		Secondary concrete (Class 30/19)	m^3	100	1 870	187 000
18		Unformed Surface Finishes				
		Class U2 finish	m^2	2 489	29	72 181
TOTAL CARRIED FORWARD TO SUMMARY						**5 952 199**

SITE A, OPTION 2
WITH
OUTLET TO TUNNEL

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
19	1-12	**Landscaping** (% of 1-9)	%	932 200 320	5	46 610 016
20	1-12	**Miscellaneous** (% of 1-9)	%	932 200 320	15	139 830 048
		SUB TOTAL A				1 118 640 384
21		**Preliminary & General** (% of sub-total A)	%	1 118 640 384	30	335 592 115
22		**Preliminary works**				
	22.1	(a) Access road	km	5	400 000	1 840 000.00
	22.2	(b) Electrical supply to site	Sum			1 000 000
	22.3	(c) Construction water to site	Sum			300 000
	22.4	(d) Railhead & materials handling	Sum			
	22.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				1 457 672 499
23		**Contingencies** (% of sub total B)	%	1 457 672 499	10	145 767 250
		SUB TOTAL C				1 603 439 749
24		**Planning design & supervision** (% of sub total C)	%	1 603 439 749	15	240 515 962
		SUB TOTAL D				1 843 955 711
25		**VAT** (% of sub total D)	%	1 843 955 711	0	0
		NETT PROJECT COST				1 843 955 711
26		**Cost of relocations**	Sum			
27		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 843 955 711

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
1	**1**	**SITE CLEARANCE**				
	1.2	Clear and grub				
		(a) Right flank footprint	ha	12.60	26 600	335 160
		(b) RCC footprint	ha	1.80	26 601	47 882
	1.3	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Whole footprint area	No	5	1 700	8 500
	1.4	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Right flank embankent	m³	38 113	21	800 373
		(b) RCC	m³	5 481	21	115 101
2	**2.0**	**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	2.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Right flank core	m³	19071	30	572 130
		(2) RCC excavation	m³	98485	30	2 954 550
		(b) Extra over for:				
		(i) Intermediate excavation	m³	35 267	4	141 067
		(ii) Hard rock excavation	m³	23 511	34	799 381
		(iii) Boulder excavation, Class A	m³	5 878	79	464 346
		(iv) Boulder excavation, Class B	m³	954	61	58 167
	2.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	5 400	665	3 591 000
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	5 400	658	3 553 200
TOTAL CARRIED FORWARD						**13 440 857**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3		**PART 2 : RIVER DIVERSION**	**Sum**	**1**		**15 000 000**
4		**EMBANKMENT**				
		SECTION: EARTHFILL DAM CONSTRUCTION				
		Embankment				
	4.1	(a) Trial Embankment	No			146 619
	4.2	(b) Forming right flank embankment				
		(1) Earth fill	m^3	1824788	46	83 940 248
		(2) Filters	m^3	80232	431	34 579 992
		(3) Riprap	m^3	374	351	131 274
		(4) Clay core	m^3	446072	50	22 303 600
5		**CONCRETE STRUCTURE**				
		SECTION: CONVENTIONAL CONCRETE FOR DAMS				
		SCHEDULED FORMWORK ITEMS				
		Class F2				
	5.1	(a) Vertical				
		(1) Wall (downstream and upstream)	m^2	44 456	610	27 118 160
		(2) Outletworks	m^2	6 210	610	3 788 100
	5.2	(c) Forming of Gallery				
		(1) Horizontal	m	411	6 500	2 671 500
		(2) Sloping	m	200	8 000	1 600 000
6		SCHEDULED REINFORCEMENT ITEMS	t	1 321	8 400	11 097 240
7		SCHEDULED CONCRETE ITEMS				
	7.1	Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Apron (160m x 1m x 23m)	m^3	3 680	1 768	6 506 240
		(2) Outlet works	m^3	9 531	1 768	16 850 808
		(3) River diversion slot	m^3	30 654	1 768	54 196 272
	7.2	UNFORMED SURFACE FINISH				
8	8.1	Class U2 (Wood-floated) finish				
		(a) Concrete wall structure	m^2	17 496	50	874 800
		(b) Apron (downstream)	m^2	3 680	50	184 000
		(c) Gallery floor	m^2	411	50	20 550
		(d) Outlet works	m^2	324	50	16 200
9		**ROAD DEVIATION TO ACCOMMODATE DAM LEVEL**				
		(a) Road (1 300 m long x 11,4 m wide)	m^2	14 820	770	11 411 400
		(b) Bridges (230 m long bridges x 11.4 m wide)	m^2	2 622	15 000	39 330 000
TOTAL CARRIED FORWARD						**331 767 003**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						**331 767 003**
10		**SECTION: ROLLER COMPACTED CONCRETE FOR DAMS**				
	10.1	Roller Compacted Concrete				
		(a) Grade 15 MPa concrete				
		(1) Wall	m^3	477 498	950	453 623 323
		(2) Additional for two separate wall sections	m^3	477 498	100	47 749 823
	10.2	(b) Immersion Vibrated Roller Compacted Concrete (IVRCC)				
		(1) 600 mm thick, upstream	m^3	13 337	1 100	14 670 401
		(2) 600 mm thick, downstream	m^2	16 410	1 100	18 051 040
	10.3	RCC Bedding Mortar				
		(a) Grade 15 MPa concrete	m^2	17 496	500	8 748 000
	9.4	Test Section	No.	1	840 000	840 000
11		**SECTION : DRILLING & GROUTING**				
	11.1	**RCC WALL**				
		(a) Curtain grouting	m	18 504	850	15 728 400
		(b) Consolidation grouting	m	4 006	850	3 405 100
	11.2	**EARTH EMABANKMENT**				
		(a) Curtain grouting	m	10 352	850	8 799 200
		(b) Consolidation grouting	m	1 714	850	1 456 900
12		**SECTION: WATERSTOPS, JOINTING AND BEARINGS**				
		SCHEDULED ITEMS				
	12.1	Waterstops	m	1 482	700	1 037 301
13		**SECTION: MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes and hoists	Sum			2 330 000
		(c) Structural steel screens and guides	Sum			1 712 971
		(d) Pipe (2 x 2m steel pipe)	m	100	20 000	2 000 000
TOTAL CARRIED FORWARD						**918 759 463**

Appendix J

Smithfield Dam site B, Option 1

BOQ

SITE B, OPTION 1
with
INLET STRUCTURE TO PUMPSTATION

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
23		**Landscaping** (% of 1-9)	%	563 852 804	5	28 192 640
24		**Miscellaneous** (% of 1-9)	%	563 852 804	15	84 577 921
		SUB TOTAL A				676 623 365
25		**Preliminary & General** (% of sub-total A)	%	676 623 365	30	202 987 010
26		**Preliminary works**				
	26.1	(a) Access road	km	4.6	400 000	1 840 000
	26.2	(b) Electrical supply to site	Sum			1 000 000
	26.3	(c) Construction water to site	Sum			300 000
	26.4	(d) Railhead & materials handling	Sum			
	26.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				883 050 375
27		**Contingencies** (% of sub total B)	%	883 050 375	10	88 305 037
		SUB TOTAL C				971 355 412
28		**Planning design & supervision** (% of sub total C)	%	971 355 412	15	145 703 312
		SUB TOTAL D				1 117 058 724
29		**VAT** (% of sub total D)	%	1 117 058 724	0	0
		NETT PROJECT COST				1 117 058 724
30		**Cost of relocations**	Sum			
31		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 117 058 724

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.5	26 546	39 819
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	4525	20	90 500
2		**EXCAVATION AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	20 564	21	431 844
		(b) Extra over for:				
		(i) Intermediate	m³	5 141	3	16 965
		(ii) Hard Rock	m³	5 141	34	174 794
		(iii) Boulder, Class A	m³	2 056	78	160 399
		(iv) Boulder, Class B	m³	1 028	61	62 720
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	170 633	21	3 583 293
		(b) Extra over for:				
		(i) Intermediate	m³	42 658	3	140 772
		(ii) Hard Rock	m³	42 658	34	1 450 381
		(iii) Boulder, Class A	m³	25 595	78	1 996 406
		(iv) Boulder, Class B	m³	8 532	61	520 431
	2.3	Dewatering	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	0.5	26 546	13 273
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700	3 400
TOTAL CARRIED FORWARD						**8 788 397**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**8 788 397**
4		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	1 638	21	34 398
5		**EMBANKMENT CONSTRUCTION**				
		Earthfille Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
	5.1	Using material from designated borrow areas or commercial sources				
		(4) Homogeneous Material	m³	25269	50	1 263 450
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	37 186	2 051	76 268 896
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	15 768	37	577 314
		(b) Shotcrete	m³	756	2 500	1 891 023
		(c) Reinforcing mesh	m²	4 920	26	127 913
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
		MEDIUM PRESSURE PIPELINES				
7		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	324	80.00	25 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
8		**PLUG OF TUNNEL**				
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**92 466 061**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9	**SANS 1200 C**	**SITE CLEARANCE**				
	9.1	Clear and grub				
		(a) Main embankment footprint	ha	8.40	26 546	222 986
		(b) Spillway	ha	14.70	13 635	200 435
		(d) Saddle embankment footprint	ha	3.40	26 546	90 256
	9.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main & Saddle)	No	7	1 700	11 900
		(ii) Spillway	No	2	1 700	3 400
	9.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Embankment footprint (Main & Saddle)	m³	42 638	21	895 398
		(b) Spillway	m³	44 160	16	706 560
10		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	10.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35	0
		(2) Spillway (Use in Rockfill)	m³	0	31	0
		(3) Outlet works (Use in Rockfill)	m³	0	35	0
	10.2	(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3	0
		(ii) Hard rock excavation	m³	0	34	0
		(iii) Boulder excavation, Class A	m³	0	79	0
		(iv) Boulder excavation, Class B	m³	0	61	0
	10.3	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	10 296	664	4 864 464
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	10 296	660	4 835 160
TOTAL CARRIED FORWARD						**11 830 559**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
11	**P21**	**EMBANKMENT CONSTRUCTION**				
	11.1	Forming Embankment				
		Using material from designated borrow areas				
		Main embankment				
		(1) Rockfill	m³	1 417 432	71	100 637 672
		(2) Clay Core	m³	294 356	50	14 717 800
		(3) Filter	m³	86 534	450	38 940 300
		Saddle embankment				
		(1) Rockfill	m³	160 782	71	11 415 522
		(2) Clay Core	m³	47 931	50	2 396 550
		(3) Filter	m³	41 864	450	18 838 800
	11.2	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
		Overhaul (Clay for 10 km)	m³.km	17 114	3	51 343
12		**SECTION : DRILLING & GROUTING**				
	12.1	**Main embankment**				
		(a) Curtain grouting	m	8 464	850	7 194 400
		(b) Consolidation grouting	m	2 820	850	2 397 000
	12.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 687	850	2 283 950
		(b) Consolidation grouting	m	1 845	850	1 568 250
TOTAL CARRIED FORWARD TO SUMMARY						**200 588 587**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		Scheduled Formwork items				
	14.1	Class F4				
		(a) Vertical				
		(1) Spillway	m²	8 736	530	4 630 080
		(2) Transfer structure to pumpstation	m²	6 804	550	3 742 200
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Horizontal	m²	352	581	204 512
		Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	14.2	Scheduled Reinforcement items	t	4 737	8 400	39 792 480
	14.3	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	108	8 500	920 377
	14.4	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	36 611	1 500	54 916 500
		(2) Transfer intake to pumpstation	m³	28 628	1 500	42 942 000
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	14.5	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m^2	468	23	10 764
		(b) Top of bridges	m^2	197	23	4 531
		(c) Chute and Stilling basin floor	m²	34 320	23	789 360
		(d) Transfer intake	m²	862	25	21 540
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD						**160 010 056**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**160 010 056**
16		**WATERSTOPS, JOINTING AND BEARINGS**				
		Scheduled items				
	16.1	Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	1 799	630	1 133 496
	16.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	1 799	10	17 992
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	1 799	10	17 992
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	1 799	10	17 992
17		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	17.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	429	21	9 009
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	215	4	858
	17.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	412	550	226 512
	17.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	1 716	400	686 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	520	330	171 600
	17.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	26	50	1 300
	17.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
		Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	4 118	3	12 355
TOTAL CARRIED FORWARD TO SUMMARY						**162 310 362**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
18		**SITE CLEARANCE**				
	18.1	Clear and grub				
		(a) Footprint	ha	0.20	26 546	5 309
	18.2	Remove and grub large trees and tree stumps of				
		(a) over 1 m and up to and including 2 m				
		(i) Footprint	No	1	1 700	1 700
	18.3	Remove topsoil to nominal depth of 300 mm and				
		(a) Footprint	m³	600	21	12 600
19		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	19.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or				
		(i) Stockpile				
		(1) Embankment footprint	m³	46400	35	1 624 000
		(b) Extra over for:				
		(i) Intermediate excavation	m³	13 920	3	44 544
		(ii) Hard rock excavation	m³	9 280	34	315 520
		(iii) Boulder excavation, Class A	m³	2 320	79	182 120
		(iv) Boulder excavation, Class B	m³	2 320	61	141 520
	19.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	600	664	398 400
		(b) Treatment of Faults, Dykes, Shear Zones and	m³	600	660	398 400
20		Scheduled Reinforcement items				
		Steel				
		(a) High tensile steel 16 mm diameter and over	t	3 430	8 400	28 809 984
21		Scheduled Concrete items				
	21.1	Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m³	100	1 869	186 900
	21.2	Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m³	42 872	1 500	64 308 000
	21.3	Secondary concrete (Class 30/19)	m³	100	1 870	187 000
22		Unformed Surface Finishes				
		Class U2 finish	m²	1 422	29	41 238
TOTAL CARRIED FORWARD TO SUMMARY						**96 657 235**

SITE B, OPTION 1
with
INLET STRUCTURE TO TUNNEL

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
18		**Landscaping** (% of 1-9)	%	471 859 003	5	23 592 950
19		**Miscellaneous** (% of 1-9)	%	471 859 003	15	70 778 850
		SUB TOTAL A				566 230 804
20		**Preliminary & General** (% of sub-total A)	%	566 230 804	30	169 869 241
21		**Preliminary works**				
	21.1	(a) Access road	km	4.6	400 000	1 840 000
	21.2	(b) Electrical supply to site	Sum			1 000 000
	21.3	(c) Construction water to site	Sum			300 000
	21.4	(d) Railhead & materials handling	Sum			
	21.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				739 540 045
22		**Contingencies** (% of sub total B)	%	739 540 045	10	73 954 004
		SUB TOTAL C				813 494 049
23		**Planning design & supervision** (% of sub total C)	%	813 494 049	15	122 024 107
		SUB TOTAL D				935 518 157
24		**VAT** (% of sub total D)	%	935 518 157	0	0
		NETT PROJECT COST				935 518 157
25		**Cost of relocations**	Sum			
26		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				935 518 157

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.5	26 546	39 819
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	4525	20	90 500
2		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	20 564	21	431 844
		(b) Extra over for:				
		(i) Intermediate	m³	5 141	3	16 965
		(ii) Hard Rock	m³	5 141	34	174 794
		(iii) Boulder, Class A	m³	2 056	78	160 399
		(iv) Boulder, Class B	m³	1 028	61	62 720
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	170 633	21	3 583 293
		(b) Extra over for:				
		(i) Intermediate	m³	42 658	3	140 772
		(ii) Hard Rock	m³	42 658	34	1 450 381
		(iii) Boulder, Class A	m³	25 595	78	1 996 406
		(iv) Boulder, Class B	m³	8 532	61	520 431
	2.3	**Dewatering**	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	0.5	26 546	13 273
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700	3 400
TOTAL CARRIED FORWARD						**8 788 397**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**8 788 397**
4		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	1 638	21	34 398
5		**EMBANKMENT CONSTRUCTION** Earthfille Upstream & Downstream Cofferdam Construction. Forming Embankment				
		(4) Homogeneous Material	m³	25269	50	1 263 450
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	37 186	2 051	76 268 896
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	15 768	37	577 314
		(b) Shotcrete	m³	756	2 500	1 891 023
		(c) Reinforcing mesh	m²	4 920	26	127 913
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
7		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	324	80.00	25 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
		CONVENTIONAL CONCRETE FOR DAMS				
8		**PLUG OF TUNNEL**				
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**92 466 061**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
8		**SITE CLEARANCE**				
	8.1	Clear and grub				
		(a) Main embankment footprint	ha	8.40	26 546	222 986
		(b) Spillway	ha	14.70	13 635	200 435
		(d) Saddle embankment footprint	ha	3.40	26 546	90 256
	8.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main & Saddle)	No	7	1 700	11 900
		(ii) Spillway	No	2	1 700	3 400
	8.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Embankment footprint (Main & Saddle)	m³	42 638	21	895 398
		(b) Spillway	m³	44 160	16	706 560
9		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	9.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35	0
		(2) Spillway (Use in Rockfill)	m³	0	31	0
		(3) Outlet works (Use in Rockfill)	m³	0	35	0
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3	0
		(ii) Hard rock excavation	m³	0	34	0
		(iii) Boulder excavation, Class A	m³	0	79	0
		(iv) Boulder excavation, Class B	m³	0	61	0
10		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	10 296	664	4 864 464
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	10 296	660	4 835 160
TOTAL CARRIED FORWARD						**11 830 559**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
11		**EMBANKMENT CONSTRUCTION**				
	11.1	Forming Embankment				
		Using material from designated borrow areas				
		Main embankment				
		(1) Rockfill	m³	1 417 432	71	100 637 672
		(2) Clay Core	m³	294 356	50	14 717 800
		(3) Filter	m³	86 534	450	38 940 300
		Saddle embankment				
		(1) Rockfill	m³	160 782	71	11 415 522
		(2) Clay Core	m³	47 931	50	2 396 550
		(3) Filter	m³	41 864	450	18 838 800
	11.2	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
	11.3	Overhaul (Clay for 10 km)	m³.km	17 114	3	51 343
12		**SECTION : DRILLING & GROUTING**				
	12.1	**Main embankment**				
		(a) Curtain grouting	m	8 464	850	7 194 400
		(b) Consolidation grouting	m	2 820	850	2 397 000
	12.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 687	850	2 283 950
		(b) Consolidation grouting	m	1 845	850	1 568 250
TOTAL CARRIED FORWARD TO SUMMARY						**200 588 587**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
13		**CONVENTIONAL CONCRETE FOR DAMS**				
	13.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	8 736	530	4 630 080
		(2) Transfer structure to tunnels	m²	6 804	550	3 742 200
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(2) Round	m²	2 337	581	1 357 797
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Horizontal	m²	352	581	204 512
	13.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	13.3	Scheduled Reinforcement items	t	4 878	8 400	40 978 392
	13.4	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	108	8 500	920 377
	13.5	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	36 611	1 500	54 916 500
		(2) Transfer intake to tunnel	m³	30 040	1 500	45 059 700
	13.6	Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	13.7	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m^2	468	23	10 764
		(b) Top of bridges	m^2	197	23	4 531
		(c) Chute and Stilling basin floor	m²	34 320	23	789 360
		(d) Transfer intake	m²	943	25	23 565
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD						**164 673 490**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**164 673 490**
16		**WATERSTOPS, JOINTING AND BEARINGS**				
		Scheduled items				
	16.1	Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	1 799	630	1 133 496
	16.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	1 799	10	17 992
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	1 799	10	17 992
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	1 799	10	17 992
17		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	17.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	429	21	9 009
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	215	4	858
	17.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	412	550	226 512
	17.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	1 716	400	686 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	520	330	171 600
	17.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	26	50	1 300
	17.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
	17.6	Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	4 118	3	12 355
TOTAL CARRIED FORWARD TO SUMMARY						**166 973 796**

SITE B, OPTION 3
with
INLET STRUCTURE TO PUMPSTATION

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
23		**Landscaping** (% of 1-9)	%	504 046 829	5	25 202 341
24		**Miscellaneous** (% of 1-9)	%	504 046 829	15	75 607 024
		SUB TOTAL A				604 856 195
25		**Preliminary & General** (% of sub-total A)	%	604 856 195	30	181 456 858
26		**Preliminary works**				
	26.1	(a) Access road	km	5	400 000	1 840 000.00
	26.2	(b) Electrical supply to site	Sum			1 000 000
	26.3	(c) Construction water to site	Sum			300 000
	26.4	(d) Railhead & materials handling	Sum			
	26.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				789 753 053
27		**Contingencies** (% of sub total B)	%	789 753 053	10	78 975 305
		SUB TOTAL C				868 728 359
28		**Planning design & supervision** (% of sub total C)	%	868 728 359	15	130 309 254
		SUB TOTAL D				999 037 613
29		**VAT** (% of sub total D)	%	999 037 613	0	0
		NETT PROJECT COST				999 037 613
30		**Cost of relocations**	Sum			
31		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				999 037 613

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.5	26 546	39 819
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	4525	20	90 500
2		**EXCAVATION AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	20 564	21	431 844
		(b) Extra over for:				
		(i) Intermediate	m³	5 141	3	16 965
		(ii) Hard Rock	m³	5 141	34	174 794
		(iii) Boulder, Class A	m³	2 056	78	160 399
		(iv) Boulder, Class B	m³	1 028	61	62 720
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	170 633	21	3 583 293
		(b) Extra over for:				
		(i) Intermediate	m³	42 658	3	140 772
		(ii) Hard Rock	m³	42 658	34	1 450 381
		(iii) Boulder, Class A	m³	25 595	78	1 996 406
		(iv) Boulder, Class B	m³	8 532	61	520 431
	2.3	**Dewatering**	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	0.5	26 546	13 273
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700.00	3 400
TOTAL CARRIED FORWARD						**8 788 397**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**8 788 397**
4		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	1 638	21	34 398
5		**EMBANKMENT CONSTRUCTION**				
		Earthfill Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
		Using material from designated borrow areas or commercial sources				
		(4) Homogeneous Material	m³	25269	50	1 263 450
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	37 186	2 051	76 268 896
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	15 768	37	577 314
		(b) Shotcrete	m³	756	2 500	1 891 023
		(c) Reinforcing mesh	m²	4 920	26	127 913
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
7		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	324	80	25 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
8		**PLUG OF TUNNEL**				.
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19 mm	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**92 466 061**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9		**SITE CLEARANCE**				
	9.1	Clear and grub				
		(a) Main embankment footprint	ha	8.40	26 546	222 986
		(b) Spillway	ha	18.90	13 635	257 702
		(c) Outlet Works	ha	0.20	13 635	2 727
		(d) Saddle embankment footprint	ha	3.40	26 546	90 256
	9.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main & Saddle)	No	7	1 700	11 900
		(ii) Spillway	No	5	1 700	8 500
		(iii) Outlet works	No	2	1 700	3 400
	9.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Embankment footprint (Main & Saddle)	m³	42 638	21	895 398.00
		(b) Spillway	m³	57 288	16	916 608.00
		(c) Outlet/Inlet works	m³	750	21	15 750.00
10		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	10.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35.00	0.00
		(2) Spillway (Use in Rockfill)	m³	0	31.00	0.00
		(3) Outlet works (Use in Rockfill)	m³	0	35.00	0.00
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3.20	0.00
		(ii) Hard rock excavation	m³	0	34.00	0.00
		(iii) Boulder excavation, Class A	m³	0	78.50	0.00
		(iv) Boulder excavation, Class B	m³	0	61.00	0.00
11		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	1 881	664	1 248 984
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	1 881	660	1 241 460
TOTAL CARRIED FORWARD						**4 915 671**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
12		**EMBANKMENT CONSTRUCTION**				
	12.1	Forming Embankment				
		Using material from designated borrow areas				
		Main embankment				
		(1) Rockfill	m³	1 417 432	71	100 637 672
		(2) Clay Core	m³	294 356	50	14 717 800
		(3) Filter	m³	86 534	450	38 940 300
		Saddle embankment				
		(1) Rockfill	m³	160 782	71	11 415 522
		(2) Clay Core	m³	47 931	50	2 396 550
		(3) Filter	m³	41 864	450	18 838 800
	12.2	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
	12.3	Overhaul (Clay for 10 km)	m³.km	17 114	3	51 343
	12.4	Overhaul (Rockfill frm spillway 1km)	m³km	1 417 432	3	4 252 296
13		**SECTION : DRILLING & GROUTING**				
	13.1	**Main embankment**				
		(a) Curtain grouting	m	8 464	850	7 194 400
		(b) Consolidation grouting	m	2 820	850	2 397 000
	13.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 687	850	2 283 950
		(b) Consolidation grouting	m	1 845	850	1 568 250
TOTAL CARRIED FORWARD TO SUMMARY						**204 840 883**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		**CONVENTIONAL CONCRETE FOR DAMS**				
	14.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	1 444	530	765 320
		(2) Transfer structure to tunnels	m²	6 804	550	3 742 200
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Horizontal	m²	352	581	204 512
	14.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	14.3	Scheduled Reinforcement items	t	3 410	8 400	28 643 160
	14.4	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	20	8 500	168 146
	14.5	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	10 713	1 500	16 069 500
		(2) Transfer intake to pumpstation	m³	28 628	1 500	42 942 000
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	14.6	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m²	86	23	1 967
		(b) Top of bridges	m²	197	23	4 531
		(c) Chute and Stilling basin floor	m²	6 270	23	144 210
		(d) Transfer intake	m²	862	25	21 550
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD						**104 742 807**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**104 742 807.23**
16		**WATERSTOPS, JOINTING AND BEARINGS**				
	16.1	Scheduled items				
		Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	329	630	207 081
		Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	329	10	3 287
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	329	10	3 287
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	329	10	3 287
17		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	17.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	78	21	1 646
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	39	4	157
	17.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	75	550	41 382
	17.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	314	400	125 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	95	330	31 350
	17.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	5	50	238
	17.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
	17.6	Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	752	3	2 257
TOTAL CARRIED FORWARD TO SUMMARY						**105 166 978.55**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
18		**SITE CLEARANCE**				
	18.1	Clear and grub				
		(a) Footprint	ha	0.20	26 546	5 309
	18.2	Remove and grub large trees and tree stumps of				
		(a) over 1 m and up to and including 2 m				
		(i) Footprint	No	1	1 700	1 700
	18.3	Remove topsoil to nominal depth of 300 mm and				
		(a) Footprint	m³	600	21	12 600
19		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	19.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or				
		(i) Stockpile				
		(1) Embankment footprint	m³	46400	35	1 624 000
		(b) Extra over for:				
		(i) Intermediate excavation	m³	13 920	3	44 544
		(ii) Hard rock excavation	m³	9 280	34	315 520
		(iii) Boulder excavation, Class A	m³	2 320	79	182 120
		(iv) Boulder excavation, Class B	m³	2 320	61	141 520
	19.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	600	664	398 400
		(b) Treatment of Faults, Dykes, Shear Zones and	m³	600	660	398 400
20		Scheduled Reinforcement items				
		Steel				
		(a) High tensile steel 16 mm diameter and over	t	3 430	8 400	28 809 984
21		Scheduled Concrete items				
	21.1	Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m³	100	1 869	186 900
	21.2	Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m³	42 872	1 500	64 308 000
	21.3	Secondary concrete (Class 30/19)	m³	100	1 870	187 000
22		Unformed Surface Finishes				
		Class U2 finish	m²	1 422	29	41 238
TOTAL CARRIED FORWARD TO SUMMARY						**96 657 235**

SITE B, OPTION 3
with
Tunnel inlet structure

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
18		**Landscaping** (% of 1-9)	%	412 053 028	5	20 602 651
19		**Miscellaneous** (% of 1-9)	%	412 053 028	15	61 807 954
		SUB TOTAL A				494 463 634
20		**Preliminary & General** (% of sub-total A)	%	494 463 634	30	148 339 090
21		**Preliminary works**				
	21.1	(a) Access road	km	5	400 000	1 840 000.00
	21.2	(b) Electrical supply to site	Sum			1 000 000
	21.3	(c) Construction water to site	Sum			300 000
	21.4	(d) Railhead & materials handling	Sum			
	21.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				646 242 724
22		**Contingencies** (% of sub total B)	%	646 242 724	10	64 624 272
		SUB TOTAL C				710 866 996
23		**Planning design & supervision** (% of sub total C)	%	710 866 996	15	106 630 049
		SUB TOTAL D				817 497 045
24		**VAT** (% of sub total D)	%	817 497 045	0	0
		NETT PROJECT COST				817 497 045
25		**Cost of relocations**	Sum			
26		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				817 497 045

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.5	26 546	39 819
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	4525	20	90 500
2		**EXCAVATION AND BACKFILL FOR DAMS AND** Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	20 564	21	431 844
		(b) Extra over for:				
		(i) Intermediate	m³	5 141	3	16 965
		(ii) Hard Rock	m³	5 141	34	174 794
		(iii) Boulder, Class A	m³	2 056	78	160 399
		(iv) Boulder, Class B	m³	1 028	61	62 720
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	170 633	21	3 583 293
		(b) Extra over for:				
		(i) Intermediate	m³	42 658	3	140 772
		(ii) Hard Rock	m³	42 658	34	1 450 381
		(iii) Boulder, Class A	m³	25 595	78	1 996 406
		(iv) Boulder, Class B	m³	8 532	61	520 431
	2.3	**Dewatering**	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	0.5	26 546	13 273
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700.00	3 400
TOTAL CARRIED FORWARD						**8 788 397**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**8 788 397**
4		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	1 638	21	34 398
5		**EMBANKMENT CONSTRUCTION**				
		Earthfille Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
		Using material from designated borrow areas or commercial				
		(4) Homogeneous Material	m³	25269	50	1 263 450
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	37 186	2 051	76 268 896
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	15 768	37	577 314
		(b) Shotcrete	m³	756	2 500	1 891 023
		(c) Reinforcing mesh	m²	4 920	26	127 913
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
7		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	324	80	25 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
8		**PLUG OF TUNNEL**				.
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**92 466 061**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9		**SITE CLEARANCE**				
	9.1	Clear and grub				
		(a) Main embankment footprint	ha	8.40	26 546	222 986
		(b) Spillway	ha	18.90	13 635	257 702
		(c) Outlet Works	ha	0.20	13 635	2 727
		(d) Saddle embankment footprint	ha	3.40	26 546	90 256
	9.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main & Saddle)	No	7	1 700	11 900
		(ii) Spillway	No	5	1 700	8 500
		(iii) Outlet works	No	2	1 700	3 400
	9.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Embankment footprint (Main & Saddle)	m³	42 638	21	895 398.00
		(b) Spillway	m³	57 288	16	916 608.00
		(c) Outlet/Inlet works	m³	750	21	15 750.00
10		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	10.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35.00	0.00
		(2) Spillway (Use in Rockfill)	m³	0	31.00	0.00
		(3) Outlet works (Use in Rockfill)	m³	0	35.00	0.00
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3.20	0.00
		(ii) Hard rock excavation	m³	0	34.00	0.00
		(iii) Boulder excavation, Class A	m³	0	78.50	0.00
		(iv) Boulder excavation, Class B	m³	0	61.00	0.00
11		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	1 881	664	1 248 984
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	1 881	660	1 241 460
TOTAL CARRIED FORWARD						**4 915 671**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
12		**EMBANKMENT CONSTRUCTION**				
	12.1	Forming Embankment				
		Using material from designated borrow areas				
		Main embankment				
		(1) Rockfill	m³	1 417 432	71	100 637 672
		(2) Clay Core	m³	294 356	50	14 717 800
		(3) Filter	m³	86 534	450	38 940 300
		Saddle embankment				
		(1) Rockfill	m³	160 782	71	11 415 522
		(2) Clay Core	m³	47 931	50	2 396 550
		(3) Filter	m³	41 864	450	18 838 800
	12.2	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
	12.3	Overhaul (Clay for 10 km)	m³.km	17 114	3	51 343
	12.4	Overhaul (Rockfill from spillway for 1 km)	m³.km	1 417 432	3	4 252 296
13		**SECTION : DRILLING & GROUTING**				
	13.1	**Main embankment**				
		(a) Curtain grouting	m	8 464	850	7 194 400
		(b) Consolidation grouting	m	2 820	850	2 397 000
	13.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 687	850	2 283 950
		(b) Consolidation grouting	m	1 845	850	1 568 250
TOTAL CARRIED FORWARD TO SUMMARY						**204 840 883**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		**CONVENTIONAL CONCRETE FOR DAMS**				
	14.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	1 444	530	765 320
		(2) Transfer structure to tunnels	m²	6 804	550	3 742 200
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(2) Round	m²	2 337	581	1 357 797
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Horizontal	m²	352	581	204 512
	14.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	14.3	Scheduled Reinforcement items	t	3 551	8 400	29 829 072
	14.4	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	20	8 500	168 146
	14.5	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	10 713	1 500	16 069 500
		(2) Transfer intake tunnel	m³	30 040	1 500	45 059 700
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	14.6	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m^2	86	23	1 967
		(b) Top of bridges	m^2	197	23	4 531
		(c) Chute and Stilling basin floor	m²	6 270	23	144 210
		(d) Transfer intake	m²	943	25	23 575
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD						**109 406 241**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**109 406 241.23**
16		**WATERSTOPS, JOINTING AND BEARINGS**				
	16.1	Scheduled items				
		Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	329	630	207 081
	16.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	329	10	3 287
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	329	10	3 287
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	329	10	3 287
17		**SUB-SOIL DRAINAGE**				
	17.1	Scheduled items				
		Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	78	21	1 646
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	39	4	157
		Natural permeable material in sub-soil drainage systems				
	17.2	(b) Sand as specified on detail drawings	m³	75	550	41 382
	17.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	314	400	125 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	95	330	31 350
	17.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	5	50	238
	17.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
		Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	752	3	2 257
TOTAL CARRIED FORWARD TO SUMMARY						**109 830 412.55**

Appendix K

Smithfield Dam site B, Option 2

BOQ

SITE B, OPTION 2
with
INLET STRUCTURE TO PUMPSTATION

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
16		**Landscaping** (% of 1-9)	%	795 841 237	5	39 792 062
17		**Miscellaneous** (% of 1-9)	%	795 841 237	15	119 376 186
		SUB TOTAL A				955 009 485
18		**Preliminary & General** (% of sub-total A)	%	955 009 485	30	286 502 845
19		**Preliminary works**				
	19.1	(a) Access road	km	5	400 000	1 840 000.00
	19.2	(b) Electrical supply to site	Sum			1 000 000
	19.3	(c) Construction water to site	Sum			300 000
	19.4	(d) Railhead & materials handling	Sum			
	19.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				1 244 952 330
20		**Contingencies** (% of sub total B)	%	1 244 952 330	10	124 495 233
		SUB TOTAL C				1 369 447 563
21		**Planning design & supervision** (% of sub total C)	%	1 369 447 563	15	205 417 134
		SUB TOTAL D				1 574 864 697
22		**VAT** (% of sub total D)	%	1 574 864 697	0	0
		NETT PROJECT COST				1 574 864 697
23		**Cost of relocations**	Sum			
24		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 574 864 697

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Right Earth embankment	ha	5.40	26 600	143 640
		(b) RCC	ha	1.80	26 600	47 880
		(c) Left Embankment	ha	0.40	26 600	10 640
		(d) Saddle embankment	ha	3.40	26 600	90 440
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Whole footprint area	No	10	1 700	17 000
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Right Earth embankment	m³	16 723	21	351 183
		(b) RCC	m³	5 413	21	113 673
		(c) Left Embankment	m³	8 883	21	186 543
		(d) Saddle embankment	m³	17 140	21	359 940
2		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	2.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) RCC excavation	m³	88395	30	2 651 850
		(2) Right flank core excavation	m³	73418	30	2 202 540
		(3) Left flank core excavation	m³	43391	30	1 301 730
		(4) Saddle dam core excavation	m³	6782	30	203 460
		(5) Outlet works	m³	16240	30	487 200
		(b) Extra over for:				
		(i) Intermediate excavation	m³	68 468	4	273 871
		(ii) Hard rock excavation	m³	45 645	34	1 551 937
		(iii) Boulder excavation, Class A	m³	11 411	79	901 493
		(iv) Boulder excavation, Class B	m³	11 411	61	696 089
3		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	5 880	665	3 910 200
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	5 880	658	3 869 040
TOTAL CARRIED FORWARD						**19 370 349**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
		EMBANKMENT				
5		**SECTION: EARTHFILL DAM CONSTRUCTION**				
		Embankment				
		(a) Trial Embankment	No			146 619
		(b) Forming right flank embankment				
		(1) Earth fill	m³	383775	46	17 653 650
		(2) Filters	m³	16059	431	6 921 429
		(3) Riprap	m³	224	351	78 624
		(4) Clay core	m³	93360	50	4 668 000
		(b) Forming left flank embankment				
		(1) Earth fill	m³	185481	46	8 532 126
		(2) Filters	m³	15032	431	6 478 792
		(3) Riprap	m³	131	351	45 981
		(4) Clay core	m³	48724	50	2 436 200
		(b) Forming saddle embankment				
		(1) Earth fill	m³	130207	46	5 989 522
		(2) Filters	m³	27117	431	11 687 427
		(3) Riprap	m³	520	351	182 520
		(4) Clay core	m³	41866	50	2 093 300
6		**CONCRETE STRUCTURE**				
		SECTION: CONVENTIONAL CONCRETE FOR				
	6.1	SCHEDULED FORMWORK ITEMS				
		Class F2				
		(a) Vertical				
		(1) Wall (downstream and upstream)	m^2	40 817	610	24 898 370
		(2) Transfer structure to pumpstation	m²	6 804	550	3 742 200
		(c) Forming of Gallery				
		(1) Horizontal	m	414	6 500	2 691 000
		(2) Sloping	m	391	8 000	3 128 000
	6.2	SCHEDULED REINFORCEMENT ITEMS	t	3 258	8 400	27 368 712
	6.3	SCHEDULED CONCRETE ITEMS				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Apron (160m x 1m x 22m)	m³	3 520	1 768	6 223 360
		(2) Transfer intake to pumpstation	m³	29 062	1 500	43 592 700
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	6.4	UNFORMED SURFACE FINISH				
		Class U2 (Wood-floated) finish				
		(a) Concrete wall structure	m^2	17 496	50	874 800
		(b) Apron (downstream)	m^2	3 520	50	176 000
		(c) Gallery floor	m^2	453	50	22 650
		(d) Transfer intake	m²	862	25	21 550
TOTAL CARRIED FORWARD						**180 013 532**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						**180 013 532**
7		**SECTION: ROLLER COMPACTED CONCRETE FOR**				
	7.1	Roller Compacted Concrete				
		(a) Grade 15 MPa concrete				
		(1) Wall	m^3	411 352	950	390 784 400
		(2) Additional for river diversion slot (Not continuous placing of RCC)	m^3	411 352	100	41 135 200
		(b) Immersion Vibrated Roller Compacted Concrete				
		(1) 600 mm thick, upstream	m^3	12 245	1 100	13 469 500
		(2) 600 mm thick, downstream	m^2	15 123	1 100	16 635 300
	7.2	RCC Bedding Mortar				
		(a) Grade 15 MPa concrete	m^2	5 400	500	2 700 000
	7.3	Test Section	No.	1	840 000	840 000
8		**SECTION : DRILLING & GROUTING**				
	8.1	**Right embankment**				
		(a) Curtain grouting	m	3 826	850	3 252 100
		(b) Consolidation grouting	m	1 111	850	944 350
	8.2	**RCC**				
		(a) Curtain grouting	m	11 602	850	9 861 700
		(b) Consolidation grouting	m	3 915	850	3 327 750
	8.3	**Left embankment**				
		(a) Curtain grouting	m	1 340	850	1 139 000
		(b) Consolidation grouting	m	700	850	595 000
	8.4	**Saddle**				
		(a) Curtain grouting	m	1 209	850	1 027 650
		(b) Consolidation grouting	m	2 650	850	2 252 500
9		**SECTION: WATERSTOPS, JOINTING AND BEARINC**				
		SCHEDULED ITEMS				
	9.1	Waterstops	m	1 361	700	952 700
10		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD TO SUMMARY						**679 813 653**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
11		**SITE CLEARANCE**				
	11.1	Clear and grub				
		(a) Footprint	ha	0.20	26 546	5 309
	11.2	Remove and grub large trees and tree stumps of				
		(a) over 1 m and up to and including 2 m				
		(i) Footprint	No	1	1 700	1 700
	11.3	Remove topsoil to nominal depth of 300 mm and				
		(a) Footprint	m³	600	21	12 600
12		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	12.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or				
		(i) Stockpile				
		(1) Embankment footprint	m³	46400	35	1 624 000
		(b) Extra over for:				
		(i) Intermediate excavation	m³	13 920	3	44 544
		(ii) Hard rock excavation	m³	9 280	34	315 520
		(iii) Boulder excavation, Class A	m³	2 320	79	182 120
		(iv) Boulder excavation, Class B	m³	2 320	61	141 520
	12.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	600	664	398 400
		(b) Treatment of Faults, Dykes, Shear Zones and	m³	600	660	398 400
13		Scheduled Reinforcement items				
		Steel				
		(a) High tensile steel 16 mm diameter and over	t	3 430	8 400	28 809 984
14		Scheduled Concrete items				
	14.1	Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m³	100	1 869	186 900
	14.2	Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m³	42 872	1 500	64 308 000
	14.3	Secondary concrete (Class 30/19)	m³	100	1 870	187 000
15		Unformed Surface Finishes				
		Class U2 finish	m²	1 422	29	41 238
TOTAL CARRIED FORWARD TO SUMMARY						**96 657 235**

SITE B, OPTION 3
with
Tunnel inlet structure

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
18		**Landscaping** (% of 1-9)	%	412 053 028	5	20 602 651
19		**Miscellaneous** (% of 1-9)	%	412 053 028	15	61 807 954
		SUB TOTAL A				494 463 634
20		**Preliminary & General** (% of sub-total A)	%	494 463 634	30	148 339 090
21		**Preliminary works**				
	21.1	(a) Access road	km	5	400 000	1 840 000.00
	21.2	(b) Electrical supply to site	Sum			1 000 000
	21.3	(c) Construction water to site	Sum			300 000
	21.4	(d) Railhead & materials handling	Sum			
	21.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				646 242 724
22		**Contingencies** (% of sub total B)	%	646 242 724	10	64 624 272
		SUB TOTAL C				710 866 996
23		**Planning design & supervision** (% of sub total C)	%	710 866 996	15	106 630 049
		SUB TOTAL D				817 497 045
24		**VAT** (% of sub total D)	%	817 497 045	0	0
		NETT PROJECT COST				817 497 045
25		**Cost of relocations**	Sum			
26		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				817 497 045

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.5	26 546	39 819
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	4525	20	90 500
2		**EXCAVATION AND BACKFILL FOR DAMS AND** Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	20 564	21	431 844
		(b) Extra over for:				
		(i) Intermediate	m³	5 141	3	16 965
		(ii) Hard Rock	m³	5 141	34	174 794
		(iii) Boulder, Class A	m³	2 056	78	160 399
		(iv) Boulder, Class B	m³	1 028	61	62 720
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	170 633	21	3 583 293
		(b) Extra over for:				
		(i) Intermediate	m³	42 658	3	140 772
		(ii) Hard Rock	m³	42 658	34	1 450 381
		(iii) Boulder, Class A	m³	25 595	78	1 996 406
		(iv) Boulder, Class B	m³	8 532	61	520 431
	2.3	**Dewatering**	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	0.5	26 546	13 273
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700.00	3 400
TOTAL CARRIED FORWARD						**8 788 397**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**8 788 397**
4		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	1 638	21	34 398
5		**EMBANKMENT CONSTRUCTION**				
		Earthfille Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
		Using material from designated borrow areas or commercial				
		(4) Homogeneous Material	m³	25269	50	1 263 450
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	37 186	2 051	76 268 896
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	15 768	37	577 314
		(b) Shotcrete	m³	756	2 500	1 891 023
		(c) Reinforcing mesh	m²	4 920	26	127 913
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
7		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	324	80	25 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
8		**PLUG OF TUNNEL**				.
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**92 466 061**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9		**SITE CLEARANCE**				
	9.1	Clear and grub				
		(a) Main embankment footprint	ha	8.40	26 546	222 986
		(b) Spillway	ha	18.90	13 635	257 702
		(c) Outlet Works	ha	0.20	13 635	2 727
		(d) Saddle embankment footprint	ha	3.40	26 546	90 256
	9.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main & Saddle)	No	7	1 700	11 900
		(ii) Spillway	No	5	1 700	8 500
		(iii) Outlet works	No	2	1 700	3 400
	9.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Embankment footprint (Main & Saddle)	m³	42 638	21	895 398.00
		(b) Spillway	m³	57 288	16	916 608.00
		(c) Outlet/Inlet works	m³	750	21	15 750.00
10		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	10.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35.00	0.00
		(2) Spillway (Use in Rockfill)	m³	0	31.00	0.00
		(3) Outlet works (Use in Rockfill)	m³	0	35.00	0.00
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3.20	0.00
		(ii) Hard rock excavation	m³	0	34.00	0.00
		(iii) Boulder excavation, Class A	m³	0	78.50	0.00
		(iv) Boulder excavation, Class B	m³	0	61.00	0.00
11		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	1 881	664	1 248 984
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	1 881	660	1 241 460
TOTAL CARRIED FORWARD						**4 915 671**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
12		**EMBANKMENT CONSTRUCTION**				
	12.1	Forming Embankment				
		Using material from designated borrow areas				
		Main embankment				
		(1) Rockfill	m³	1 417 432	71	100 637 672
		(2) Clay Core	m³	294 356	50	14 717 800
		(3) Filter	m³	86 534	450	38 940 300
		Saddle embankment				
		(1) Rockfill	m³	160 782	71	11 415 522
		(2) Clay Core	m³	47 931	50	2 396 550
		(3) Filter	m³	41 864	450	18 838 800
	12.2	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
	12.3	Overhaul (Clay for 10 km)	m³.km	17 114	3	51 343
	12.4	Overhaul (Rockfill from spillway for 1 km)	m³.km	1 417 432	3	4 252 296
13		**SECTION : DRILLING & GROUTING**				
	13.1	**Main embankment**				
		(a) Curtain grouting	m	8 464	850	7 194 400
		(b) Consolidation grouting	m	2 820	850	2 397 000
	13.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 687	850	2 283 950
		(b) Consolidation grouting	m	1 845	850	1 568 250
TOTAL CARRIED FORWARD TO SUMMARY						**204 840 883**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		**CONVENTIONAL CONCRETE FOR DAMS**				
	14.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	1 444	530	765 320
		(2) Transfer structure to tunnels	m²	6 804	550	3 742 200
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(2) Round	m²	2 337	581	1 357 797
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Horizontal	m²	352	581	204 512
	14.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	14.3	Scheduled Reinforcement items	t	3 551	8 400	29 829 072
	14.4	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	20	8 500	168 146
	14.5	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	10 713	1 500	16 069 500
		(2) Transfer intake tunnel	m³	30 040	1 500	45 059 700
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	14.6	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m^2	86	23	1 967
		(b) Top of bridges	m^2	197	23	4 531
		(c) Chute and Stilling basin floor	m²	6 270	23	144 210
		(d) Transfer intake	m²	943	25	23 575
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD						**109 406 241**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**109 406 241.23**
16		**WATERSTOPS, JOINTING AND BEARINGS**				
	16.1	Scheduled items				
		Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	329	630	207 081
	16.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	329	10	3 287
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	329	10	3 287
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	329	10	3 287
17		**SUB-SOIL DRAINAGE**				
	17.1	Scheduled items				
		Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	78	21	1 646
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	39	4	157
		Natural permeable material in sub-soil drainage systems				
	17.2	(b) Sand as specified on detail drawings	m³	75	550	41 382
	17.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	314	400	125 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	95	330	31 350
	17.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	5	50	238
	17.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
		Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	752	3	2 257
TOTAL CARRIED FORWARD TO SUMMARY						**109 830 412.55**

Appendix L

Smithfield Dam site B, Option 3

BOQ

SITE B, OPTION 3
with
INLET STRUCTURE TO PUMPSTATION

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
23		**Landscaping** (% of 1-9)	%	504 046 829	5	25 202 341
24		**Miscellaneous** (% of 1-9)	%	504 046 829	15	75 607 024
		SUB TOTAL A				604 856 195
25		**Preliminary & General** (% of sub-total A)	%	604 856 195	30	181 456 858
26		**Preliminary works**				
	26.1	(a) Access road	km	5	400 000	1 840 000.00
	26.2	(b) Electrical supply to site	Sum			1 000 000
	26.3	(c) Construction water to site	Sum			300 000
	26.4	(d) Railhead & materials handling	Sum			
	26.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				789 753 053
27		**Contingencies** (% of sub total B)	%	789 753 053	10	78 975 305
		SUB TOTAL C				868 728 359
28		**Planning design & supervision** (% of sub total C)	%	868 728 359	15	130 309 254
		SUB TOTAL D				999 037 613
29		**VAT** (% of sub total D)	%	999 037 613	0	0
		NETT PROJECT COST				999 037 613
30		**Cost of relocations**	Sum			
31		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				999 037 613

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	1.5	26 546	39 819
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	4525	20	90 500
2		**EXCAVATION AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	20 564	21	431 844
		(b) Extra over for:				
		(i) Intermediate	m³	5 141	3	16 965
		(ii) Hard Rock	m³	5 141	34	174 794
		(iii) Boulder, Class A	m³	2 056	78	160 399
		(iv) Boulder, Class B	m³	1 028	61	62 720
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	170 633	21	3 583 293
		(b) Extra over for:				
		(i) Intermediate	m³	42 658	3	140 772
		(ii) Hard Rock	m³	42 658	34	1 450 381
		(iii) Boulder, Class A	m³	25 595	78	1 996 406
		(iv) Boulder, Class B	m³	8 532	61	520 431
	2.3	**Dewatering**	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	0.5	26 546	13 273
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700.00	3 400
TOTAL CARRIED FORWARD						**8 788 397**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**8 788 397**
4		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	1 638	21	34 398
5		**EMBANKMENT CONSTRUCTION**				
		Earthfill Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
		Using material from designated borrow areas or commercial sources				
		(4) Homogeneous Material	m³	25269	50	1 263 450
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	37 186	2 051	76 268 896
	6.2	ROCK SUPPORT				
		(a) Rockbolts	m	15 768	37	577 314
		(b) Shotcrete	m³	756	2 500	1 891 023
		(c) Reinforcing mesh	m²	4 920	26	127 913
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
7		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	324	80	25 920
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
8		**PLUG OF TUNNEL**				.
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19 mm	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**92 466 061**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9		**SITE CLEARANCE**				
	9.1	Clear and grub				
		(a) Main embankment footprint	ha	8.40	26 546	222 986
		(b) Spillway	ha	18.90	13 635	257 702
		(c) Outlet Works	ha	0.20	13 635	2 727
		(d) Saddle embankment footprint	ha	3.40	26 546	90 256
	9.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main & Saddle)	No	7	1 700	11 900
		(ii) Spillway	No	5	1 700	8 500
		(iii) Outlet works	No	2	1 700	3 400
	9.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Embankment footprint (Main & Saddle)	m³	42 638	21	895 398.00
		(b) Spillway	m³	57 288	16	916 608.00
		(c) Outlet/Inlet works	m³	750	21	15 750.00
10		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	10.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35.00	0.00
		(2) Spillway (Use in Rockfill)	m³	0	31.00	0.00
		(3) Outlet works (Use in Rockfill)	m³	0	35.00	0.00
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3.20	0.00
		(ii) Hard rock excavation	m³	0	34.00	0.00
		(iii) Boulder excavation, Class A	m³	0	78.50	0.00
		(iv) Boulder excavation, Class B	m³	0	61.00	0.00
11		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	1 881	664	1 248 984
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of	m³	1 881	660	1 241 460
TOTAL CARRIED FORWARD						**4 915 671**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
12		**EMBANKMENT CONSTRUCTION**				
	12.1	Forming Embankment				
		Using material from designated borrow areas				
		Main embankment				
		(1) Rockfill	m³	1 417 432	71	100 637 672
		(2) Clay Core	m³	294 356	50	14 717 800
		(3) Filter	m³	86 534	450	38 940 300
		Saddle embankment				
		(1) Rockfill	m³	160 782	71	11 415 522
		(2) Clay Core	m³	47 931	50	2 396 550
		(3) Filter	m³	41 864	450	18 838 800
	12.2	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
	12.3	Overhaul (Clay for 10 km)	m³.km	17 114	3	51 343
	12.4	Overhaul (Rockfill frm spillway 1km)	m³km	1 417 432	3	4 252 296
13		**SECTION : DRILLING & GROUTING**				
	13.1	**Main embankment**				
		(a) Curtain grouting	m	8 464	850	7 194 400
		(b) Consolidation grouting	m	2 820	850	2 397 000
	13.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 687	850	2 283 950
		(b) Consolidation grouting	m	1 845	850	1 568 250
TOTAL CARRIED FORWARD TO SUMMARY						**204 840 883**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		**CONVENTIONAL CONCRETE FOR DAMS**				
	14.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	1 444	530	765 320
		(2) Transfer structure to tunnels	m²	6 804	550	3 742 200
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Horizontal	m²	352	581	204 512
	14.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	14.3	Scheduled Reinforcement items	t	3 410	8 400	28 643 160
	14.4	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	20	8 500	168 146
	14.5	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	10 713	1 500	16 069 500
		(2) Transfer intake to pumpstation	m³	28 628	1 500	42 942 000
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	200	1 800	360 000
	14.6	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m²	86	23	1 967
		(b) Top of bridges	m²	197	23	4 531
		(c) Chute and Stilling basin floor	m²	6 270	23	144 210
		(d) Transfer intake	m²	862	25	21 550
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD						**104 742 807**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**104 742 807.23**
16		**WATERSTOPS, JOINTING AND BEARINGS**				
	16.1	Scheduled items				
		Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	329	630	207 081
		Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	329	10	3 287
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	329	10	3 287
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	329	10	3 287
17		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	17.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m³	78	21	1 646
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	39	4	157
	17.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	75	550	41 382
	17.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	314	400	125 400
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	95	330	31 350
	17.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	5	50	238
	17.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
	17.6	Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	752	3	2 257
TOTAL CARRIED FORWARD TO SUMMARY						**105 166 978.55**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
18		**SITE CLEARANCE**				
	18.1	Clear and grub				
		(a) Footprint	ha	0.20	26 546	5 309
	18.2	Remove and grub large trees and tree stumps of				
		(a) over 1 m and up to and including 2 m				
		(i) Footprint	No	1	1 700	1 700
	18.3	Remove topsoil to nominal depth of 300 mm and				
		(a) Footprint	m³	600	21	12 600
19		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	19.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or				
		(i) Stockpile				
		(1) Embankment footprint	m³	46400	35	1 624 000
		(b) Extra over for:				
		(i) Intermediate excavation	m³	13 920	3	44 544
		(ii) Hard rock excavation	m³	9 280	34	315 520
		(iii) Boulder excavation, Class A	m³	2 320	79	182 120
		(iv) Boulder excavation, Class B	m³	2 320	61	141 520
	19.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	600	664	398 400
		(b) Treatment of Faults, Dykes, Shear Zones and	m³	600	660	398 400
20		Scheduled Reinforcement items				
		Steel				
		(a) High tensile steel 16 mm diameter and over	t	3 430	8 400	28 809 984
21		Scheduled Concrete items				
	21.1	Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m³	100	1 869	186 900
	21.2	Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m³	42 872	1 500	64 308 000
	21.3	Secondary concrete (Class 30/19)	m³	100	1 870	187 000
22		Unformed Surface Finishes				
		Class U2 finish	m²	1 422	29	41 238
TOTAL CARRIED FORWARD TO SUMMARY						**96 657 235**

Appendix M

Smithfield Dam site C, Option 1

BOQ

SITE C, OPTION 1
WITH
INLET STRUCTURE TO TUNNEL

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
23		**Landscaping** (% of 1-9)	%	620 632 225	5	31 031 611
24		**Miscellaneous** (% of 1-9)	%	620 632 225	15	93 094 834
		SUB TOTAL A				744 758 670
25		**Preliminary & General** (% of sub-total A)	%	744 758 670	30	223 427 601
26		**Preliminary works**				
	26.1	(a) Access road	km	5	400 000	1 840 000.00
	26.2	(b) Electrical supply to site	Sum			1 000 000
	26.3	(c) Construction water to site	Sum			300 000
	26.4	(d) Railhead & materials handling	Sum			
	26.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				971 626 271
27		**Contingencies** (% of sub total B)	%	971 626 271	10	97 162 627
		SUB TOTAL C				1 068 788 899
28		**Planning design & supervision** (% of sub total C)	%	1 068 788 899	15	160 318 335
		SUB TOTAL D				1 229 107 233
29		**VAT** (% of sub total D)	%	1 229 107 233	0	0
		NETT PROJECT COST				1 229 107 233
30		**Cost of relocations**	Sum			
31		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 229 107 233

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	3.6	26 546	95 948
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile	m³	10842	20	216 840
2		**EXCAVATION AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	178 826	21	3 755 346
		(b) Extra over for:				
		(i) Intermediate	m³	44 707	3	147 531
		(ii) Hard Rock	m³	44 707	34	1 520 021
		(iii) Boulder, Class A	m³	17 883	78	1 394 843
		(iv) Boulder, Class B	m³	8 941	61	545 419
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	303 202	21	6 367 242
		(b) Extra over for:				
		(i) Intermediate	m³	75 801	3	250 142
		(ii) Hard Rock	m³	75 801	34	2 577 217
		(iii) Boulder, Class A	m³	45 480	78	3 547 463
		(iv) Boulder, Class B	m³	15 160	61	924 766
	2.3	**Dewatering**	Sum	1	100 000	100 000
		STAGE 2				
3		**SITE CLEARANCE**				
	3.1	Clear and grub				
		(a) Embankment footprint	ha	2.2	26 546	59 147
	3.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m	No	2	1 700	3 400
TOTAL CARRIED FORWARD						**21 508 726**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**21 508 726**
4		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
		(a) Excavate all materials				
		(i) Topsoil at Upstream & Downstream cofferdam	m³	6 685	21	140 385
5		**EMBANKMENT CONSTRUCTION**				
		Earthfill Upstream & Downstream Cofferdam Construction.				
		Forming Embankment				
		Using material from designated borrow areas or commercial				
	5.1	(4) Homogeneous Material	m³	163242	50	8 162 100
6		**TUNNEL CONSTRUCTION**				
	6.1	TUNNEL EXCAVATION				
		(a) Tunnel (Rock class II)	m³	57053	2051	117 015 293
	6.2	ROCK SUPPORT				
		(a) Rockbots	m	24192	37	895 104
		(b) Shotcrete	m³	803	2500	2 006 948
		(c) Reinforcing mesh	m²	5221	26	135 755
	6.3	DEWATERING	Sum	1	550 000	550 000
		STAGE 3				
		MEDIUM PRESSURE PIPELINES				
7		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	333	80	26 640
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
		CONVENTIONAL CONCRETE FOR DAMS				
8		**PLUG OF TUNNEL**				
	8.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	310	550	170 500
	8.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19	m³	1 050	1 100	1 155 000
		(c) Plug 25 MPa/19 mm	m³	708	1 100	778 250
	8.3	Joints				
		(e) Swellable water stops	m	30	500	15 000
	8.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	240	3 000	720 000
TOTAL CARRIED FORWARD TO SUMMARY						**153 379 700**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
10		**SITE CLEARANCE**				
	10.1	Clear and grub				
		(a) Main & Saddle embankment footprint	ha	7.73	26 546	205 245
		(b) Spillway	ha	9.40	13 635	128 169
		(c) Outlet Works	ha	0.41	13 635	5 530
	10.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Main & saddle embankment footprint	No	7	1 700	11 900
		(ii) Spillway	No	2	1 700	3 400
		(iii) Outlet works	No	3	1 700	5 100
	10.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) Main & Saddle embankment footprint	m³	24 590	21	516 390
		(b) Spillway	m³	28 625	16	458 000
		(c) Outlet/Inlet works	m³	1 217	21	25 553
11		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	11.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35	0
		(2) Spillway (Use in Rockfill)	m³	0	31	0
		(3) Outlet works (Use in Rockfill)	m³	0	35	0
		(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3	0
		(ii) Hard rock excavation	m³	0	34	0
		(iii) Boulder excavation, Class A	m³	0	79	0
		(iv) Boulder excavation, Class B	m³	0	61	0
12		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	4 737	664.00	3 145 368
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	4 737	660.00	3 126 420
TOTAL CARRIED FORWARD						**7 631 074.99**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
13		**EMBANKMENT CONSTRUCTION**				
		Forming Embankment				
		Using material from designated borrow areas				
	13.1	Main embankment				
		(1) Rockfill	m³	1 519 916	71	107 914 036
		(2) Clay Core	m³	311 495	50	15 574 750
		(3) Filter	m³	87 847	450	39 531 150
	13.2	Saddle embankment				
		(1) Rockfill	m³	123 615	71	8 776 665
		(2) Clay Core	m³	72 557	50	3 627 850
		(3) Filter	m³	30 456	450	13 705 200
	13.3	Rockfill trial (test) Embankment size as per specification	No	1	147 000	147 000
	13.4	Overhaul (Clay for 10 km)	m³.km	75 996	3.00	227 987
14		**SECTION : DRILLING & GROUTING**				
	14.1	**Main embankment**				
		(a) Curtain grouting	m	7 074	850	6 012 900
		(b) Consolidation grouting	m	1 080	850	918 000
	14.2	**Saddle Embankment**				
		(a) Curtain grouting	m	2 890	850	2 456 500
		(b) Consolidation grouting	m	1 406	850	1 195 100
15		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
TOTAL CARRIED FORWARD TO SUMMARY						**210 970 109.40**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
16	16.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	4 988	530	2 643 640
		(2) Outlet works	m²	6 888	530	3 650 640
		(b) Sloped				
		(1) Ogee of spillway	m²	1 328	581	771 568
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	581	19 173
		(d) Round	m²	2 337	581	1 357 797
		(e) Horisontal	m²	352	581	204 512
	16.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	16.3	Scheduled Reinforcement items	t	3 787	8 400	31 809 960
17		Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	45	8 500	380 540
18		Scheduled Concrete items				
	18.1	Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	30 843	1 500	46 264 500
		(2) Outlet works	m³	30 040	1 500	45 060 000
	18.2	Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	100	1 800	180 000
19		Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m^2	194	23	4 451
		(b) Top of bridges	m^2	197	23	4 531
		(c) Chute and Stilling basin floor	m²	14 190	23	326 370
		(d) Outlet works	m²	772	23	17 756
20		ADDITIONAL TRANSFER TUNNEL COST DUE TO				
	20.1	(a) Additional tunnel	m	2 300	50 000	115 000 000
TOTAL CARRIED FORWARD						**247 697 438**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**247 697 438**
21		**WATERSTOPS, JOINTING AND BEARINGS**				
		Scheduled items				
	21.1	Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	744	630	468 657
	21.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	744	10	7 439
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	744	10	7 439
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	744	10	7 439
22		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	22.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following				
		(i) 0 m to 1,5 m	m³	177	21	3 725
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m³	89	4	355
	22.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m³	170	550	93 654
	22.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	710	400	283 800
		(d) 75 NB, flexible slotted drainage pipes with smooth bore,	m	215	330	70 950
	22.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	11	50	538
	22.5	Concrete outlet structures for sub-soil drainage systems				
		(a) Concrete 1500 mm dia	No	8	600	4 800
	22.6	Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m³.km	1 703	3	5 108
TOTAL CARRIED FORWARD TO SUMMARY						**248 651 341**

Appendix N

Smithfield Dam site C, Option 2

BOQ

SITE C, OPTION 2
with
OUTLET TO PUMPSTATION

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
10		**Landscaping** (% of 1-9)	%	834 114 425	5	41 705 721
11		**Miscellaneous** (% of 1-9)	%	834 114 425	15	125 117 164
		SUB TOTAL A				1 000 937 310
12		**Preliminary & General** (% of sub-total A)	%	1 000 937 310	30	300 281 193
13		**Preliminary works**				
	13.1	(a) Access road	km	5	400 000	1 840 000.00
	13.2	(b) Electrical supply to site	Sum			1 000 000
	13.3	(c) Construction water to site	Sum			300 000
	13.4	(d) Railhead & materials handling	Sum			
	13.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				1 304 658 503
14		**Contingencies** (% of sub total B)	%	1 304 658 503	10	130 465 850
		SUB TOTAL C				1 435 124 353
15		**Planning design & supervision** (% of sub total C)	%	1 435 124 353	15	215 268 653
		SUB TOTAL D				1 650 393 006
16		**VAT** (% of sub total D)	%	1 650 393 006	0	0
		NETT PROJECT COST				1 650 393 006
17		**Cost of relocations**	Sum			
18		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 650 393 006

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Excavation of RCC wall footprint	ha	3.00	26 600.00	79 800.00
		(b) Saddle footprint	ha	2.20	26 601	58 522
		(c) Outlet works	ha	0.16	13 625	2 180
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main and Saddle)	No	5	1 700	8 500
		(ii) Outlet works	No	2	1 700	3 400
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) RCC excavation - removal of topsoil	m³	9 300	21	195 300
		(b) Saddle topsoil	m³	6 600	22	145 200
		(c) Outlet works	m³	480	22	10 560
2		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) RCC foundation excavation	m³	224779	30	6 743 370
		(2) Saddle embankment core excavation	m³	5493	30	164 790
		(3) Outlet works	m³	16240	30	487 200
		(b) Extra over for:				
		(i) Intermediate excavation	m³	73 954	4	295 814
		(ii) Hard rock excavation	m³	73 954	34	2 514 422
		(iii) Boulder excavation, Class A	m³	12 326	79	973 722
		(iv) Boulder excavation, Class B	m³	12 326	61	751 862
3		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	5 173	665	3 439 979
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	5 173	658	3 403 768
TOTAL CARRIED FORWARD						**19 278 390**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
4		**SECTION: EARTHFILL DAM CONSTRUCTION**				
	4.1	Embankment				
		(a) Trial Embankment	No			146 619
		(b) Forming Embankment (Saddle)				
		(1) Earthfill	m^3	120987	46	5 565 402
		(2) Filters	m^3	37443	431	16 137 933
		(3) Riprap	m^3	271	351	95 121
		(4) Clay core	m^3	68524	50	3 426 200
		SCHEDULED REINFORCMENT ITEMS				
5		**SECTION: CONVENTIONAL CONCRETE FOR DAMS**				
	5.1	SCHEDULED FORMWORK ITEMS				
		Class F2				
		(a) Vertical				
		(1) Wall (downstream and upstream)	m^2	42 270	610	25 784 700
		(2) Outlet structure to pumpstation	m^2	6 804	550	3 742 200
		(c) Forming of Gallery				
		(1) Horizontal	m	70	2 000	140 000
		(2) Sloping	m	370	3 000	1 110 000
	5.2	SCHEDULED REINFORCEMENT ITEMS	t	2 619	8 400	22 002 624
	5.3	SCHEDULED CONCRETE ITEMS				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Apron (160m x 1m x 23m)	m^3	3 680	1 768	6 506 240
		(2) Transfer intake to pumpstation	m^3	29 062	1 500	43 593 000
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m^3	200	1 800	360 000
	5.4	UNFORMED SURFACE FINISH				
		Class U2 (Wood-floated) finish				
		(a) Concrete wall structure	m^2	17 871	50	893 550
		(b) Apron (downstream)	m^2	3 680	50	184 000
		(c) Gallery floor	m^2	440	50	22 000
		(d) Transfer intake	m^2	862	50	43 100
TOTAL CARRIED FORWARD						**129 752 689**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						**129 752 689**
6		**SECTION: ROLLER COMPACTED CONCRETE FOR DAMS**				
	6.1	Roller Compacted Concrete				
		(a) Grade 15 MPa concrete				
		(1) Wall	m^3	447 789	950	425 399 550
		(b) Immersion Vibrated Roller Compacted Concrete (IVRCC)				
		(1) 600 mm thick, upstream	m^2	12 783	350	4 474 050
		(2) 600 mm thick, downstream	m^2	51 924	350	18 173 400
	6.2	RCC Bedding Mortar				
		(a) Grade 15 MPa concrete	m^2	4 693	100	469 290
	6.3	Test Section	No.	1	840 000	840 000
7		**SECTION: DRILLING & GROUTING**				
	7.1	RCC				
		(a) Curtain grouting	m^3	7 975	850	6 778 750
		(b) Consolidation grouting	m^3	2 412	850	2 050 200
	7.2	Saddle				
		(a) Curtain grouting	m^3	2 468	850	2 097 800
		(b) Consolidation grouting	m^3	1 406	850	1 195 100
8		**SECTION: WATERSTOPS, JOINTING AND BEARINGS**				
		SCHEDULED ITEMS				
		Waterstops	m	1420	750	1 065 000
9		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
20		ADDITIONAL TRANSFER TUNNEL COST DUE TO FURTHER SITE				
	20.1	(a) Additional tunnel	m	2 300	50 000	115 000 000
TOTAL CARRIED FORWARD TO SUMMARY						**718 178 800**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
11		**SITE CLEARANCE**				
	11.1	Clear and grub				
		(a) Footprint	ha	0.20	26 546	5 309
	11.2	Remove and grub large trees and tree stumps of				
		(a) over 1 m and up to and including 2 m				
		(i) Footprint	No	1	1 700	1 700
	11.3	Remove topsoil to nominal depth of 300 mm and				
		(a) Footprint	m³	600	21	12 600
12		**EXCAVATIONS AND BACKFILL FOR DAMS AND**				
	12.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or				
		(i) Stockpile				
		(1) Embankment footprint	m³	46400	35	1 624 000
		(b) Extra over for:				
		(i) Intermediate excavation	m³	13 920	3	44 544
		(ii) Hard rock excavation	m³	9 280	34	315 520
		(iii) Boulder excavation, Class A	m³	2 320	79	182 120
		(iv) Boulder excavation, Class B	m³	2 320	61	141 520
	12.2	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	600	664	398 400
		(b) Treatment of Faults, Dykes, Shear Zones and	m³	600	660	398 400
13		Scheduled Reinforcement items				
		Steel				
		(a) High tensile steel 16 mm diameter and over	t	3 430	8 400	28 809 984
14		Scheduled Concrete items				
	14.1	Blinding layer and Dental Concrete				
		(b) Dental concrete (Class 15/38)	m³	100	1 869	186 900
	14.2	Strength and Mass Concrete				
		(a) Strength Concrete (Class 30/38)	m³	42 872	1 500	64 308 000
	14.3	Secondary concrete (Class 30/19)	m³	100	1 870	187 000
15		Unformed Surface Finishes				
		Class U2 finish	m²	1 422	29	41 238
TOTAL CARRIED FORWARD TO SUMMARY						**96 657 235**

SITE C, OPTION 2
with
OUTLET TO TUNNEL

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
11		**Landscaping** (% of 1-9)	%	742 214 661	5	37 110 733
12		**Miscellaneous** (% of 1-9)	%	742 214 661	15	111 332 199
		SUB TOTAL A				890 657 593
13		**Preliminary & General** (% of sub-total A)	%	890 657 593	30	267 197 278
14		**Preliminary works**				
	13.1	(a) Access road	km	5	400 000	1 840 000.00
	13.2	(b) Electrical supply to site	Sum			1 000 000
	13.3	(c) Construction water to site	Sum			300 000
	13.4	(d) Railhead & materials handling	Sum			
	13.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				1 161 294 871
14		**Contingencies** (% of sub total B)	%	1 161 294 871	10	116 129 487
		SUB TOTAL C				1 277 424 358
15		**Planning design & supervision** (% of sub total C)	%	1 277 424 358	15	191 613 654
		SUB TOTAL D				1 469 038 012
16		**VAT** (% of sub total D)	%	1 469 038 012	0	0
		NETT PROJECT COST				1 469 038 012
17		**Cost of relocations**	Sum			
18		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				1 469 038 012

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Excavation of RCC wall footprint	ha	3.00	26 600.00	79 800.00
		(b) Saddle footprint	ha	2.20	26 601	58 522
		(c) Outlet works	ha	0.41	13 625	5 586
	1.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint (Main and Saddle)	No	5	1 700	8 500
		(ii) Outlet works	No	3	1 700	5 100
	1.3	Remove topsoil to nominal depth of 150 mm and stockpile				
		(a) RCC excavation - removal of topsoil	m³	9 300	21	195 300
		(b) Saddle topsoil	m³	6 600	22	145 200
		(c) Outlet works	m³	1 217	22	26 774
2		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
		Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) RCC foundation excavation	m³	224779	30	6 743 370
		(2) Saddle embankment core excavation	m³	5493	30	164 790
		(3) Outlet works	m³	16471	30	494 127
		(b) Extra over for:				
		(i) Intermediate excavation	m³	74 023	4	296 091
		(ii) Hard rock excavation	m³	74 023	34	2 516 778
		(iii) Boulder excavation, Class A	m³	12 337	79	974 634
		(iv) Boulder excavation, Class B	m³	12 337	61	752 566
3		**FOUNDATION TREATMENT**				
		(a) Treatment of Joints, Cracks and Fissures	m³	5 923	665	3 938 729
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	5 923	658	3 897 268
TOTAL CARRIED FORWARD						**20 303 136**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
4		**SECTION: EARTHFILL DAM CONSTRUCTION**				
	4.1	Embankment				
		(a) Trial Embankment	No			146 619
		(b) Forming Embankment (Saddle)				
		(1) Earthfill	m^3	120987	46	5 565 402
		(2) Filters	m^3	37443	431	16 137 933
		(3) Riprap	m^3	271	351	95 121
		(4) Clay core	m^3	68524	50	3 426 200
5		**SECTION: CONVENTIONAL CONCRETE FOR DAMS**				
	5.1	SCHEDULED FORMWORK ITEMS				
		Class F2				
		(a) Vertical				
		(1) Wall (downstream and upstream)	m^2	42 270	610	25 784 700
		(2) Outlet structure to pumpstation	m^2	6 888	550	3 788 400
		(c) Forming of Gallery				
		(1) Horizontal	m	70	2 000	140 000
		(2) Sloping	m	370	3 000	1 110 000
		(e) Round	m^2	2 337	581	1 357 797
		(f) Horizontal	m^2	352	581	204 512
	5.2	SCHEDULED REINFORCEMENT ITEMS	t	2 698	8 400	22 659 840
	5.3	SCHEDULED CONCRETE ITEMS				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Apron (160m x 1m x 23m)	m^3	3 680	1 768	6 506 240
		(2) Transfer intake to pumpstation	m^3	30 040	1 500	45 060 000
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m^3	200	1 800	360 000
	5.4	UNFORMED SURFACE FINISH				
		Class U2 (Wood-floated) finish				
		(a) Concrete wall structure	m^2	17 871	50	893 550
		(b) Apron (downstream)	m^2	3 680	50	184 000
		(c) Gallery floor	m^2	440	50	22 000
		(d) Transfer intake	m^2	862	50	43 100
TOTAL CARRIED FORWARD						**133 485 414**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
TOTAL BROUGHT FORWARD						**133 485 414**
6		**SECTION: ROLLER COMPACTED CONCRETE FOR DAMS**				
	6.1	Roller Compacted Concrete				
		(a) Grade 15 MPa concrete				
		(1) Wall	m^3	447 789	950	425 399 550
		(b) Immersion Vibrated Roller Compacted Concrete (IVRCC)				
		(1) 600 mm thick, upstream	m^2	12 783	350	4 474 050
		(2) 600 mm thick, downstream	m^2	51 924	350	18 173 400
	6.2	RCC Bedding Mortar				
		(a) Grade 15 MPa concrete	m^2	4 693	100	469 290
	6.3	Test Section	No.	1	840 000	840 000
7		**SECTION: DRILLING & GROUTING**				
	7.1	RCC				
		(a) Curtain grouting	m^3	7 975	850	6 778 750
		(b) Consolidation grouting	m^3	2 412	850	2 050 200
	7.2	Saddle				
		(a) Curtain grouting	m^3	2 468	850	2 097 800
		(b) Consolidation grouting	m^3	1 406	850	1 195 100
8		**SECTION: WATERSTOPS, JOINTING AND BEARINGS**				
		SCHEDULED ITEMS				
		Waterstops	m	1420	750	1 065 000
9		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			6 840 000
		(b) Cranes & Hoists	Sum			2 330 000
		(c) Structural steelwork	Sum			1 712 971
10		**ADDITIONAL TRANSFER TUNNEL COST DUE TO**				
	10.1	(a) Additional tunnel	m	2 300	50 000	115 000 000
TOTAL CARRIED FORWARD TO SUMMARY						**721 911 525**

Appendix O

Baynesfield balancing dam, Option 2 BOQ

BAYNESFIELD DAM
OPTION 2

No	PAY REF	DESCRIPTION	UNIT	QUANTITY	RATE RAND	AMOUNT
15		**Landscaping** (% of 1-9)	%	447 907 342	5	22 395 367
16		**Miscellaneous** (% of 1-9)	%	447 907 342	15	67 186 101
		SUB TOTAL A				537 488 810
17		**Preliminary & General** (% of sub-total A)	%	537 488 810	30	161 246 643
18		**Preliminary works**				
	18.1	(a) Access road	km	2.5	400 000	1 000 000
	18.2	(b) Electrical supply to site	Sum			1 000 000
	18.3	(c) Construction water to site	Sum			300 000
	18.4	(d) Railhead & materials handling	Sum			
	18.5	(e) Accommodation	Sum			300 000
		SUB TOTAL B				701 335 453
19		**Contingencies** (% of sub total B)	%	701 335 453	10	70 133 545
		SUB TOTAL C				771 468 999
20		**Planning design & supervision** (% of sub total C)	%	771 468 999	15	115 720 350
		SUB TOTAL D				887 189 348
21		**VAT** (% of sub total D)	%	887 189 348	0	0
		NETT PROJECT COST				887 189 348
22		**Cost of relocations**	Sum			
23		**Cost of land acquisition**	Sum			
		TOTAL PROJECT COST				887 189 348

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		STAGE 1				
1		**SITE CLEARANCE**				
	1.1	Clear and grub				
		(a) Portal footprints	ha	0.23	26 546	6 087
		Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2m	No	5	1 700	8 500
	1.2	Remove topsoil to nominal depth of 150 mm and stockpile	m³	344	20	6 879
2		**EXCAVATION AND BACKFILL FOR DAMS AND** Bulk Excavation				
	2.1	**Inlet portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	3 195	21	67 095
		(b) Extra over for:				
		(i) Intermediate	m³	799	3	2 636
		(ii) Hard Rock	m³	799	34	27 158
		(iii) Boulder, Class A	m³	320	78	24 921
		(iv) Boulder, Class B	m³	160	61	9 745
	2.2	**Outlet Portal**				
		(a) Excavate in all materials				
		(i) Excavation (stockpile)	m³	127 969	21	2 687 349
		(b) Extra over for:				
		(i) Intermediate	m³	31 992	3	105 574
		(ii) Hard Rock	m³	31 992	34	1 087 737
		(iii) Boulder, Class A	m³	19 195	78	1 497 237
		(iv) Boulder, Class B	m³	6 398	61	390 305
3		**EMBANKMENT CONSTRUCTION**				
		Dewatering	Sum	1	100 000	100 000
4		First stage coffedam	Sum	1		3 831 152
		STAGE 2				
4		**SITE CLEARANCE**				
	4.1	Clear and grub				
		(a) Embankment footprint	ha	3	26 546	76 030
		Remove and grub large trees and tree stumps of girth				
	4.2	(a) over 1 m and up to and including 2 m	No	2	1 700	3 400
5		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
		(a) Excavate all materials				
		(i) Excavate and dispose footprint of Upstream cofferdam	m³	28 656	21	601 776
TOTAL CARRIED FORWARD						**10 533 581**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**10 533 581**
		EMBANKMENT CONSTRUCTION				
		Earthfill Upstream & Downstream Cofferdam Construction.				
6		Forming Embankment				
		Using material from designated borrow areas or commercial sources				
		(4) Homogeneous Material	m³	216245	50	10 812 250
7		**TUNNEL CONSTRUCTION**				
	7.1	**Tunnel excavation**				
		(a) Tunnel (Rock class II)	m³	12735	2 051	26 113 459
	7.2	**Rock support**				
		(a) Rockbolts	m	5400	37	197 710
		(b) Shotcrete	m³	652	2 500	1 630 192
		(c) Reinforcing mesh	m²	4241	26	110 270
	7.3	Dewatering	Sum	1	550 000	550 000
		STAGE 3				
8		**MEDIUM PRESSURE PIPELINES**				
		Supply, lay, and bed pipes complete with couplings				
		(a) 500 mm diameter concrete pipe (class 75D) in concrete	m	225	80	18 000
		(b) Water control in tunnel	Prov Sum	1	100 000	100 000
9		**Plug of Tunnel (Stage 3)**				
	9.1	Scheduled Formwork items				
		Class F1				
		(a) Vertical formwork	m²	124	550	68 200
	9.2	Scheduled Concrete items				
		Strength and Mass concrete				
		(a) Sealing of bulkheads shaft with mass concrete 25 Mpa/19 mm	m³	420	1 100	462 000
		(c) Plug 25 MPa/19 mm	m³	283	1 100	311 300
	9.3	Joints				
		(e) Swellable water stops	m	12	500	6 000
	9.4	Miscellaneous and Sundry items				
		(a) Bulkheads incl reinforcement at 120 kg/m³	No	96	3 000	288 000
TOTAL CARRIED FORWARD TO SUMMARY						**51 200 963**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
6		**SITE CLEARANCE**				
	6.1	Clear and grub				
		(a) Embankment footprint	ha	11.03	26 546	292 670
		(b) Spillway	ha	2.94	13 635	40 079
	6.2	Remove and grub large trees and tree stumps of girth				
		(a) over 1 m and up to and including 2 m				
		(i) Embankment footprint	No	5	1 700	8 500
		(ii) Spillway	No	2	1 700	3 400
	6.3	Remove topsoil to nominal depth of 300 mm and stockpile				
		(a) Embankment footprint	m³	33 075	21	694 575
		(b) Spillway	m³	8 818	16	141 091
7		**EXCAVATIONS AND BACKFILL FOR DAMS AND WATERWAYS**				
	7.1	Bulk Excavation				
		(a) Excavate in all materials (to stockpile or dispose)				
		(i) Stockpile				
		(1) Embankment footprint (Use in rockfill)	m³	0	35	0
		(2) Spillway (Use in Rockfill)	m³	0	31	0
		(3) Portals (Use in Rockfill)	m³	0	35	0
	7.2	(b) Extra over for:				
		(i) Intermediate excavation	m³	0	3	0
		(ii) Hard rock excavation	m³	0	34	0
		(iii) Boulder excavation, Class A	m³	0	79	0
		(iv) Boulder excavation, Class B	m³	0	61	0
	7.3	Foundation Treatment				
		(a) Treatment of Joints, Cracks and Fissures	m³	1 422	664	944 208
		(b) Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock	m³	1 422	660	938 520
TOTAL CARRIED FORWARD						**3 063 043**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
8		**EMBANKMENT CONSTRUCTION**				
	8.1	Forming Embankment				
		Using material from designated borrow areas				
		(1) Rockfill	m³	1 707 255	71	121 215 105
		(2) Clay Core	m³	380 911	50	19 045 550
		(3) Filter	m³	156 846	440	69 012 240
		Overhaul (Clay for 10 km)	m³.km	85 363	3	256 088
9		**SECTION : DRILLING & GROUTING**				
		(a) Curtain grouting	m	8 349	13 457	112 352 493
		(b) Consolidation grouting	m	2 550	2 820	7 191 000
TOTAL CARRIED FORWARD TO SUMMARY						**329 072 476**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
10		**CONVENTIONAL CONCRETE FOR DAMS**				
	10.1	Scheduled Formwork items				
		Class F4				
		(a) Vertical				
		(1) Spillway	m²	2 656	550	1 460 800
		(2) Outlet works	m²	11 643	550	6 403 650
		(3) Transfer water outlet	m²	630	550	346 500
		(b) Sloped				
		(1) Ogee of spillway - Drawing (05/02)	m²	576	550	316 800
		(2) Transfer water outlet	m²	1 533	550	843 150
		(c) Sloping				
		(1) Stilling basin blocks	m²	33	550	18 150
		(e) Horizontal Outlet works	m²	855	550	470 250
	10.2	Keyways on contraction joints				
		(a) Bridges dimensions to be given in detail design	m	20	100	2 000
	10.3	Scheduled Reinforcement items	t	387	8 400	3 250 800
	10.4	Anchors				
		Anchor bars (Y32 @ 2.5 m x 2 m)	t	15	8 500	126 085
	10.5	Scheduled Concrete items				
		Strength & Mass Concrete				
		(a) Grade 25 MPa/19 mm				
		(1) Spillway, bridges and retaining wall	m³	3 743	1 500	5 614 500
		(2) Outlet works	m³	1 899	1 500	2 848 500
		(3) Transfer structure	m³	8 820	1 500	13 230 000
		Secondary Concrete				
		(a) Grade 25 MPa/19 mm	m³	100	1 800	180 000
	10.6	Unformed Surface Finishes				
		Class U2 (Wood-floated) finish				
		(a) Top of chute	m²	135	23	3 105
		(b) Top of bridges	m²	200	23	4 600
		(c) Chute and Stilling basin floor	m²	4 500	23	103 500
		(d) Outlet works	m²	595	25	14 880
11		**MECHANICAL ITEMS**				
		(a) Valves and gates	Sum			3 420 000
		(b) Cranes & Hoists	Sum			1 713 000
		(c) Structural steelwork	Sum			1 712 971
		(d) Pipe (2 x 1diam steel pipe)	m	426	10 000	4 260 000
		(e) Transfer outlet pipes (2 x 2,5 m steel)	m	20	25 000	500 000
12		**ESKOM LINE DEVIATION**				
		(a) Pre Engineering study	Sum			1 609 757
		(b) Deviation	km	2.6290	6 000 000	15 774 000
TOTAL CARRIED FORWARD						**64 226 998**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						**64 226 998**
13		**WATERSTOPS, JOINTING AND BEARINGS**				
		Scheduled items				
	13.1	Waterstops				
		(a) 250 mm Centre bulb PVC waterstop	m	215	630	135 198
	13.2	Joint sealants				
		(a) Chute wall - 12mm expanding cork	m	215	10	2 146
		(b) Chute wall - 12m Impregnated Bitumen Fibre board	m	215	10	2 146
		(c) Chute wall - 12 x 12 mm Polysulphide sealant	m	215	10	2 146
14		**SUB-SOIL DRAINAGE**				
		Scheduled items				
	14.1	Excavation for sub-soil drainage system				
		(a) Excavating soft material situated within the following depth ranges below the surface level:				
		(i) 0 m to 1,5 m	m^3	56	21	1 181
		(b) Extra over sub-item (a), irrespective of depth, for:				
		(ii) Excavation in hard material	m^3	28	4	113
	14.2	Natural permeable material in sub-soil drainage systems				
		(b) Sand as specified on detail drawings	m^3	54	550	29 700
	14.3	Pipes in sub-soil drainage system				
		(c) 110 NB, Class 6, HDPE pressure pipe, non perforated, complying with SANS 533, Part II	m	225	400	90 000
		(d) 75 NB, flexible slotted drainage pipes with smooth bore, "Drainex" or equivalent by Kaytech	m	225	330	74 250
	14.4	Caps to higher ends of sub-surface drain pipes				
		(a) High end of pipes of Drainex pipes	No	11	50	563
	14.5	Concrete outlet structures for sub-soil drainage systems complete as per drawings				
		(a) Concrete 1500 mm dia	No	8	600	4 800
	14.6	Overhaul for material hauled in excess of 1.0 km freehaul				
		(a) Sand for filter material (10 km)	m^3.km	540	3	1 620
TOTAL CARRIED FORWARD TO SUMMARY						**64 570 860**